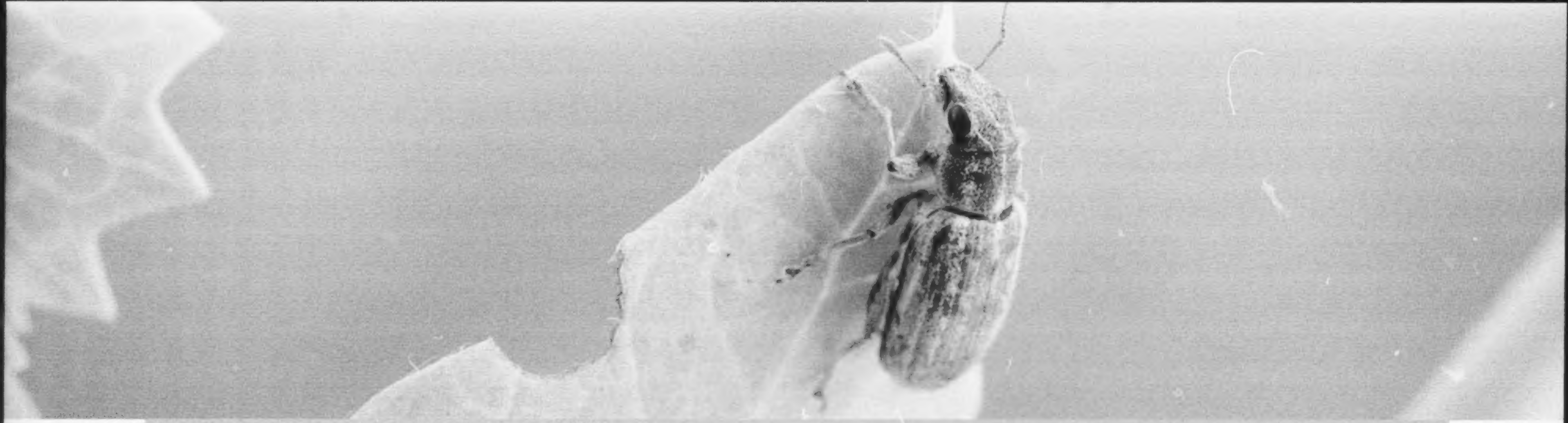

Field Crop and Forage Pests and their Natural Enemies in Western Canada:

Identification and Management

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Canada

Field Crop and Forage Pests and their
Natural Enemies in Western Canada:

Canada

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Prepared for Agriculture and Agri-Food Canada
by Hugh Philip, IPM 2 GO Consulting Service.

Field Crop and Forage Pests and their Natural Enemies in Western Canada:
Identification and Management Field Guide

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This publication is the result of a collaborative effort by many field-experienced extension and research entomologists who recognized the need for an up-to-date field guide for the accurate identification of field and forage crop pests and their natural enemies.

The information presented in this publication was contributed by the project team members from their own research or field experiences as well as that of other researchers who have made their research available for educational purposes. I wish to thank the team members for sharing their valuable time to submit information and images, and to review and provide feedback on the many draft documents. A special thanks to Erl Svendsen for coordinating the development and submission of the project proposal, for stick-handing the exchanges of draft documents, and for applying his excellent editing skills to ensure the publication will provide a useful and accurate reference for producers and their advisors, researchers, educators and others associated with field and forage crop production in Western Canada.

The team is most appreciative of the support and encouragement of Dr. Cezarina Kora, Senior Strategies Coordinator in Pest Management at Agriculture and Agri-Food Canada (AAFC), Pest Management Centre , and for the financial assistance of the Pest Management Centre which made this project possible.

Design and production: gordongroup

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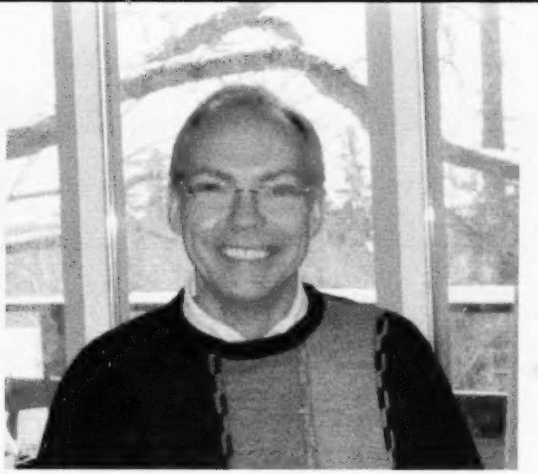

DEDICATION: TO LLOYD DOSDALL
(1952–2014)

Lloyd devoted his career to studying field crop insect pests and their natural enemies. He was known for his contagious enthusiasm and his entomological passion was divided between pesky crop bugs and aquatic entomology.

Throughout his work, his goal was to lay the ecological foundation of plant-insect relationships in order to develop sustainable pest management practices that incorporated host plant resistance, cultural strategies and natural enemies. He, his students, and post-doctoral fellows completed numerous meticulous studies on plant-insect interactions for a number of insect pests including Bertha armyworm, flea beetles, diamondback moth, root maggots, cabbage seedpod weevil and cereal leaf beetle. Thanks to these efforts, plant breeders have the information and tools for including resistance traits into new cultivars.

Lloyd left us an enormous legacy in integrated pest management that will benefit many generations of farmers on the Prairies. Lloyd was very careful to ensure that the information from research studies in agroecosystems found its way to the farming community. This was in part accomplished by collaborating wholeheartedly with agronomists, completing numerous seminal and innovative research projects with them. In addition, he took exceptional care to take photos, record videos, and write practical articles to extend the results of his work to help farmers manage crop pests in a more sustainable manner.

One of Lloyd's greatest legacies will be the people he trained either formally as a supervisor or informally through collaborations. Lloyd was highly valued and respected as a mentor by his students, post-doctoral fellows and colleagues. He gave generously of his time and worked side by side with his students to instill in them the pride and passion for entomological research. Somehow, he also found time to actively serve the regional and national entomological societies! We are fortunate that he trained many entomologists in his lab and we will see the fruits of his labour expressed in their contributions for years to come.

May this dedication be a small tribute to the work and legacy of Lloyd—friend, colleague and mentor.

Education & Background:

Lloyd studied the diversity of stoneflies (MSc) and black fly control (PhD) at the University of Saskatchewan. He then spent two years working on biting flies at the University of Manitoba before moving to Vegreville in 1989 to start work on crop insects at the Alberta Environmental Centre. In 1999, he accepted a teaching and research position at the University of Alberta, where he was active until his death.

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INTRODUCTION

The accurate identification of (a) pests, (b) the damage they cause, and (c) their natural enemies is one of six elements of a sound Integrated Pest Management (IPM) approach to suppress pest populations (p. 3). This field guide is designed to help you apply this element to make more informed decisions to control important harmful insects and mites of field and forage crops in Western Canada. Informed decisions will help save time and effort and eliminate unnecessary pesticide applications, all of which can help reduce costs. Identification of natural enemies is important in order to recognize and to foster their role in keeping or reducing their host or prey (i.e. pest) populations below economic levels.

Use the quick identification key (p. 7) to narrow your search to identify the order (i.e. major taxonomic classification ranking or group) to which the unknown insect, mite, or spider specimen belongs. The key directs you to the starting page of a specific order. There you will find descriptions and images of important pests or beneficial species belonging to that order to help you determine or confirm the identity of your specimen. The text describes diagnostic characteristics to enhance accurate identification and to reduce confusion with "look-alike" species. Each species description is accompanied by several images of the pest/beneficial insect and/or the damage they cause to help you confirm the identification of your specimen.

Technical terms are kept to a minimum. However, they are used where necessary to ensure accuracy of the species descriptions. The terms are used mainly to describe developmental life stages and insect body parts. Technical terms are defined in the Glossary (p. 141).

To encourage greater use of the other IPM elements, information about hosts, life cycle, monitoring, economic thresholds, and management options are included for each pest. For natural enemies, the guide describes their hosts/prey, life cycles, monitoring and conservation methods, and provides general comments to aid in their identification and to describe their role as biological control agents. This guide also contains a cross-reference index (p. 148) listing the major agronomic field and forage crops in Western Canada with their associated pests and natural enemies.

Only economically important field and forage crop pests and their known natural enemies are described in this field guide. These represent only a small fraction of all insects found in Western Canada. If you have found an insect or mite that you believe is causing significant economic damage that is not included in this guide, contact the Canadian Food Inspection Agency, your provincial Ministry of Agriculture, or regional diagnostic lab (see Resources, p. 142, for contact information) for assistance on identification.

Uhler's stink bug – adult
Chris Hedstrom, Oregon Department of Agriculture

Insect Development

Insects and mites develop from eggs to reproductive adults through a process called metamorphosis (changing body form). There are two types of metamorphosis among winged or secondarily wingless insects—incomplete (partial) and complete. The change in form may also involve a change in habitat or food hosts, depending on the species.

Insects that undergo incomplete metamorphosis go through three developmental stages: egg → nymph → adult. Nymphs often resemble adults except for size, colour, and lack of functional wings and reproductive appendages. Examples of this group include grasshoppers, true bugs, aphids, and leafhoppers. Nymphs moult a set number of times (usually 4–5 times) to grow and gradually develop into the adult form. The stages between moults are called instars. Nymphs and adults often share the same food hosts.

Insects that undergo complete metamorphosis go through four developmental stages: egg → larva → pupa → adult. Larvae do not resemble their adult stage and usually feed on different hosts than adults. Larvae also moult 4–5 times (also called instars between moults) before transforming into the non-mobile pupal stage. During this stage, the larvae transform into their adult form. Examples of this group include moths and butterflies; bees, wasps and ants; beetles; and flies. Insects grow only during their nymphal or larval stages.

Mites and spiders undergo very simple metamorphosis and, at immature stages, resemble adults except for size, colouration and presence of genitalia. Like insects, mites and spiders only grow during their nymphal stages.

Insect Body Structures

Adults

The adult insect body consists of the following characteristics that distinguish insects from all other groups of animals:

- Three body segments (head, thorax, and abdomen) that form a jointed, stiff exoskeleton
- Three pairs of jointed legs
- One or two pairs of wings (if present)
- One pair of compound eyes and often simple eyes (ocelli)
- One pair of jointed antennae
- Air breathing through internal air tubules (tracheae) and openings along the sides of the body (spiracles)

The head contains the mouthparts and sensory organs (compound eyes, ocelli, and antennae); the thorax contains the locomotory appendages (legs and wings); and the abdomen contains the digestive, excretory, and reproductive organs and appendages. Mouthparts are variously modified for chewing (e.g. grasshoppers), piercing and sucking (e.g. aphids), siphoning (e.g. moths), rasping and sucking (e.g. thrips), and sponging or lapping (e.g. flies). The number, structure, and appearance of wings are important characteristics for classifying insects and form the basis for the quick identification key to adult insects (p. 6).

Immature (nymphs, larvae, pupae)

Nymphs share the same body parts and structure as adults except their wings appear as short buds that gradually lengthen with each moult until becoming functional in the adult stage. External reproductive appendages (genitalia) do not appear until the adult stage.

In larvae, the body appears to have only two parts—a head and abdomen. However, larvae also have a thorax, immediately behind the head, which may have no or 3 pairs of jointed legs. The legs can vary greatly in length. The remaining segments constitute the abdomen. To aid in mobility, some larvae have short and fleshy legs called prolegs on the underside of the final segment and one or more of the abdominal segments. The body is usually very soft and flexible.

Pupae can be covered by a protective case (flies, moths, butterflies, wasps, bees, and ants); sometimes encased in a cocoon, or exposed (beetles); and usually hidden within or near the host plants.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM), a component of crop management, relies on appropriate and timely information to select and apply available pest management practices for effective, economic, and environmentally-sound suppression of pests. One of the primary purposes of IPM is to encourage the use of crop and pest management practices that encourage the development of natural enemies. This field guide provides the latest information on recommended crop and pest management practices to promote greater adoption of IPM in field crop production.

IPM has greater relevance today than when first proposed 50 years ago because of increasing public concerns over potential risks posed by pesticides. The original emphasis on reducing reliance on pesticide intervention, to avoid development of pesticide resistance, by adopting alternative pest management practices remains unchanged. Pesticide resistance can lead to increased crop losses and increased costs associated with higher application rates, more frequent applications, or the use of more costly alternative chemicals.

IPM consists of six elements. To ensure maximum effectiveness and cost savings, they should be integrated into the overall crop management system as much as possible and not performed in isolation. It is also important to keep records of all control practices and products used during the season in order to assess the performance of the inputs and to identify deficiencies that need to be corrected.

Elements of IPM

1. Prevention

Plan and manage crop production to prevent pest problems from developing

- Select crops and varieties suited to the local growing conditions and soils
- Optimize crop health to improve tolerance to pests
- Preserve native and introduced natural enemies to prevent or slow growth of pest populations
- Recognize and eliminate practices that can lead to pest problems

2. Accurate identification and knowledge of pests, pest damage, and natural enemies

Because there is no "one size fits all" solution for all pest problems, it is important to correctly identify the pest and its natural enemies, understand its behaviour, and identify the damage it causes in order to select and apply prescribed pest-specific monitoring/sampling and management practices (Elements 3–5). Application of this element results in:

- Capacity to identify pests, their damage, and natural enemies
- Understanding how pests are impacted by their natural enemies, the environment, and crop management practices
- Efficient use of time and labour to monitor/sample and to apply appropriate pest management control options
- Earlier detection of newly introduced pests leading to more rapid development of management programs to minimize crop losses

3. Monitoring pests, pest damage, natural enemies, and weather conditions

Knowing the distribution and abundance of pests, their damage, and their natural enemies in crops is essential to determine if a crop is at risk of economic injury. Monitoring involves the timely and correct application of scouting methods during the growing season to assess pest pressure (density of pests and natural enemies), crop phenology (susceptible growth stage), and weather (suitable for damage to occur).

For some insects, temperature and moisture data can be used in computer-based development models to track and forecast the appearance of pest and natural enemy life stages. The model outputs can then be used to better time pest management activities that target specific life stages. Producers can obtain this information themselves, contract for this service, or, in some areas, consult published/posted government and/or producer organizations' reports of regional monitoring/forecasting programs [see Resources p. 142].

Monitoring is also useful for evaluating the effectiveness of control actions by comparing pre- and post-treatment pest or damage levels, or comparing levels in treated and untreated (check) strips.

Insect, damage, and weather information is collected by:

- Using recommended pest monitoring tools and protocols (e.g. pheromone traps, yellow-sticky traps, pitfall traps, sampling procedures) or participating in/consulting area-wide pest monitoring programs
- Conducting visual inspection or systematically sampling crops using prescribed methods and timing, recording results for later reference, and determining economic thresholds
- Setting up a weather station to monitor and collect data to be used in pest development forecast models for improving timing of monitoring and control activities

4. Applying economic thresholds

The economic threshold is the density of pests (or damage measurement) at which control measures should be applied to prevent an increasing population from reaching the economic injury level (the density of the pest or its damage that causes losses equal to the cost of the action(s) taken to suppress the pest). Economic thresholds are based on a combination of factors: the prevalence of a pest or its damage, the crop stage and vigor, cost of the control action(s), value of the crop, and, in some cases, the prevalence of natural enemies. The economic threshold value or level is expressed as the number of insects or observed crop damage (e.g. insects/trap or insects/unit area, % leaf loss). Unfortunately thresholds are not available for many crop/pest combinations. In many cases producers must rely on their own experience or local knowledge.

Applying economic thresholds can:

- Reduce the use of insecticides because they are only applied if there is an economic benefit
- Reduce the cost of crop protection by eliminating unnecessary insecticide applications (i.e. "comfort sprays")
- Reduce risks associated with unnecessary insecticide applications (e.g. development of insecticide resistance, loss or disruption of natural enemies, unacceptable crops residues, and potential loss of markets, etc.)

5. Suppressing pest populations

Suppressing pest populations relies on information collected from Elements 2 (Identification), 3 (Monitoring/Scouting), and 4 (Economic Threshold) to select and properly apply one or more suppression options to reduce or suppress pests to densities below the economic threshold.

Suppression options include

- BIOLOGICAL CONTROL (BIOCONTROL): conservation, augmentation, or introduction of natural enemies (parasites, predators, and diseases) to keep pest populations below economic levels or to help reduce pest densities below economic levels.
  - Conservation: protecting existing populations of natural enemies by using the practices/insecticides which are least toxic to natural enemies or applying disruptive practices/products when natural enemies are not present or less active
  - Augmentation: releasing artificially reared natural enemies to an existing population (e.g. purchase and release of lady beetles)
  - Introduction: releasing a new natural enemy to control a new pest (e.g. introducing *Tetrastichus julis* to control cereal leaf beetle)

  The conditions for the development and establishment of natural enemies are not as favourable in annual crops as in perennial crops such as alfalfa. However, they do play an important role and this guide describes how they can contribute to a successful pest management program.

- CULTURAL CONTROL: purposeful manipulation of a cropping environment to prevent or suppress pest development and damage. Examples include crop rotation, planting resistant varieties, trap cropping, adjusting seeding rates and timing, minimizing tillage to conserve soil-inhabiting natural enemies, and managing alternate hosts.

- PHYSICAL/MECHANICAL CONTROL: using barriers and devices that exclude or control pests. Tillage is a form of mechanical control, destroying soil-inhabiting stages.
- BEHAVIOURAL CONTROL: taking advantage of pest responses (attraction or repulsion) to specific odours, lights and colours in order to disrupt important normal behaviours like mating, host finding, and feeding. Insect monitoring makes great use of behavioural responses (e.g. attraction to pheromone traps, yellow sticky traps, light traps). However, exploiting behavioural responses for pest control in field crops has not been applied commercially to date.
- CHEMICAL CONTROL: applying registered insecticides produced synthetically (i.e. most insecticides) or derived from natural sources (bio-pesticides) at specified rates, volumes, and timing. Where possible, insecticides should be chosen that are selective (killing specific groups of insects only) and not broad spectrum (killing most insects, including natural enemies). The use of broad spectrum insecticides can lead to the development of secondary pest problems when natural enemies are killed. Consult Appendix E, Relative Toxicity Rating of Insecticides to Common Natural Enemies of Field Crop Pests (p. 153), for guidance on selecting the least toxic insecticides.

Pests can be killed directly through contact or indirectly through ingestion of residues. In an IPM program, chemical control is used only when the non-chemical control options have failed to prevent the development of economic-level pest populations. There are no "silver bullets." An over-reliance on a single insecticide or group of insecticides (e.g. Group 4—neonicotinoids) can soon lead to the development of resistance by the target pest, making that insecticide or group obsolete. It is therefore important to adopt an insecticide resistance management program that involves employing a combination of non-chemical control options and rotating chemical control products.

It is also imperative to maintain, calibrate and operate spray equipment properly to ensure thorough and uniform crop coverage by applying the correct field rate in sufficient volume. Leaving 1 or 2 check (untreated) strips is useful to not only assess the performance of the control product, but also to compare yields and to determine the economic benefit of the treatment.

6. Evaluating results

Evaluation is an important but often ignored element. It involves looking back at what worked or did not work as a result of your pest management actions for each pest, and to determine what needs to change to improve the future outcomes of those actions. This is not simply evaluating the effectiveness of insecticide treatments, but also assessing the information generated from the identification, monitoring, and economic threshold analysis (IPM elements 2–4) you used to make your pest prevention and control action decisions. Evaluation requires accurate and up-to-date record-keeping of all pest management inputs. This means time and commitment on your part.

For many pest/crop combinations, not all IPM elements (i.e. 1 through 5 above) are available, or they are poorly developed. However, you can always evaluate the actions you took and assess their expected versus actual outcomes. After evaluating the outcome of a pest management program, you then need to (1) find the information necessary to correct deficiencies and (2) prepare a new IPM plan to address future similar pest problems.

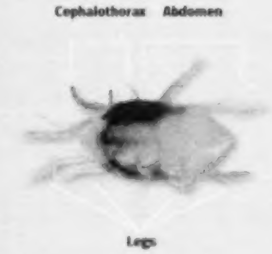
Information required for a meaningful evaluation includes:

- Preventative or proactive actions considered when making cropping plans (e.g. avoided planting a crop forecasted to be at risk of high pest pressure that season)
- Pest monitoring or sampling activity records: activity date, crop and stage of development, insect species and life stage, sampling unit, number found, and weather conditions
- Prevalence of natural enemies: crop, dates, species, and life stages
- Insecticide application: dates, product names and amount mixed/tank, spray volume/acre, target species and life stage, and weather conditions
- Insecticide efficacy assessments: measured against pre- and post-application pest monitoring/sampling
- Damage and yield assessments in sprayed crop and unsprayed checked strips (i.e. estimate of crop quality/yield loss)

Taking an IPM approach promotes adopting a variety of strategies to prevent pest build up through integration of agronomic practices and natural enemies; it does not mean abandoning use of insecticides or achieving 100% control. IPM encourages selective and judicious use of the least disruptive insecticides when other options are not available or when non-chemical options have failed to keep pest levels below economic damaging levels. Complete control is never economically justified unless the pest is of quarantine importance.

Sub-economic pest populations not only maintain populations of their natural enemies, but can also stimulate some plants to overcompensate for feeding damage and yield more. Natural enemies build up over time and if left undisturbed can often prevent pests from reaching economic levels; or they can shorten the severity and duration of insect pest outbreaks.

ACARINA[1]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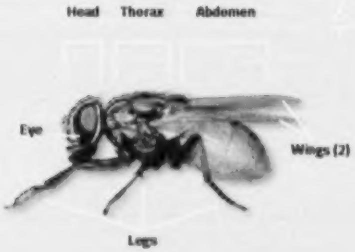
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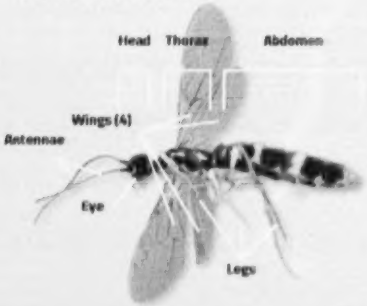
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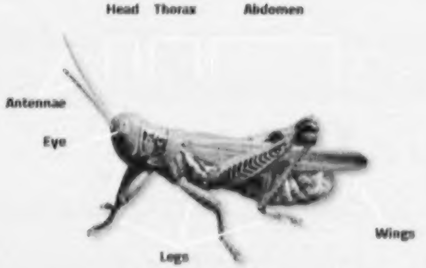
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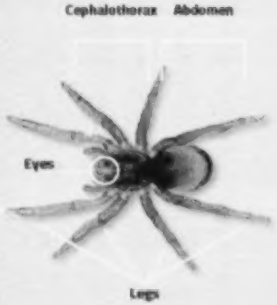
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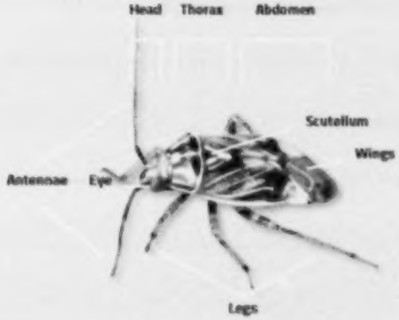
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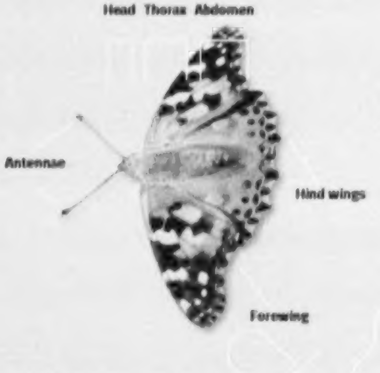
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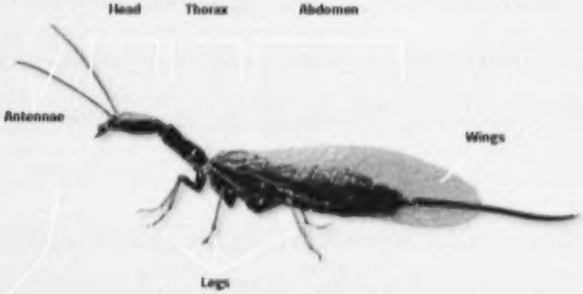
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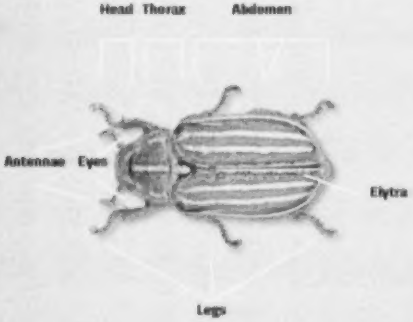
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Elytra
Legs

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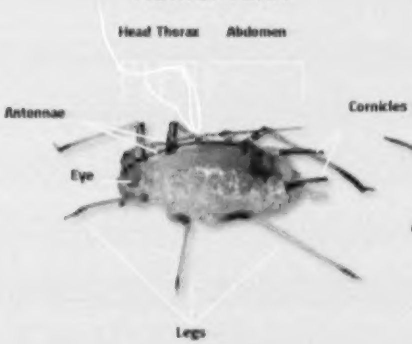
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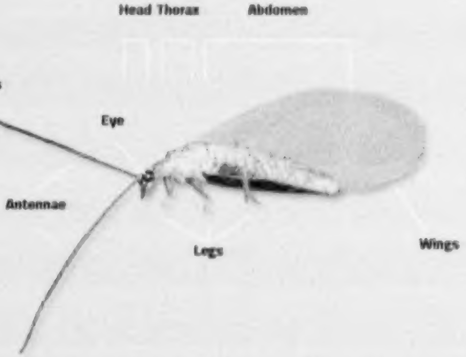
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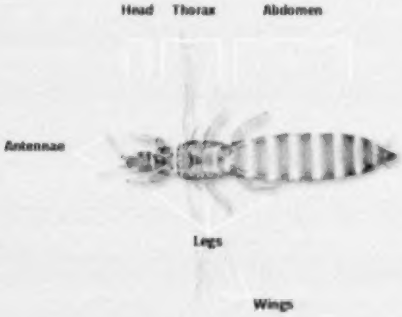
Head
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Antennae
Legs
Wings

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KEY TO THE ORDERS OF PESTS OF FIELD CROP AND THEIR NATURAL ENEMIES

This key is designed to help you identify the order a pest or natural enemy to which an unknown insect, spider or mite specimen belongs. You will not identify the species of your unknown specimen but you will be directed to where you can compare your specimen to the descriptions and images included in this guide. A 10–16X hand lens is very useful for finding and examining some of the structures described in the key, especially for small specimens.

To begin, compare your unknown specimen to the first group of statements (1). At the end of each statement there is either (a) a page number that directs you to the group to which your unknown specimen belongs or (b) the number of the next set of statements ("Go to line" column) to use to narrow down the range of possibilities. The keys identify adult and immature (nymphs and larvae) stages of development.

If you are unable to identify your specimen using this field guide, submit several specimens to a local expert or to one of the diagnostic services listed on page 144.

Adult Characteristics

Line	Description of characteristics	Go to line	Order	Pest	Natural Enemy
1	a) Body with 4 pairs of legs (except 3 pairs in mite larvae); appears to have only 1 or 2 body parts	2	Acari: mites Araneae: spiders		
	b) Body with 3 pairs of true legs (segmented); 2 or 3 body sections evident (head+abdomen; head+thorax+abdomen)	3			
2	a) Body usually 0.1 – 1 mm long (some beneficial species larger), with essentially one main body part		Acari: mites	pp. 14-16	p. 110
	b) Body >1 mm long, with 2 well-divided body parts, the cephalothorax (head+thorax) and the abdomen		Araneae: spiders		pp. 111-114
3	a) Wingless, small (<5 mm) soft-bodied, may be covered with white waxy secretion	4			
	b) Appearance otherwise	5			
4	a) Body covered in white waxy secretion, greatly reduced legs and antennae, very slow moving if at all.		Hemiptera: mealybugs	p. 71	
	b) Body bare, antennae and legs obvious, occur in colonies on plants		Hemiptera: wingless aphids	pp. 59-70	

Adult Characteristics

Line	Description of characteristics	Go to line	Order	Pest	Natural Enemy
5	a) Wings present, front pair (forewings) may be patterned, membranous, hard, leathery, or parchment-like, and covering the hind pair	6			
	b) Appearance otherwise (immature stages)	16			
6	a) One pair of wings (forewings) present, the second pair reduced to small knobs; wings membranous, transparent with occasional markings; 2–15 mm body length		Diptera: flies	pp. 35-44	pp. 118-123
	b) Two pairs of wings, size variable; if the forewing is hard, leathery, or parchment-like, assume second pair may be present beneath them	7			
7	a) Body < 2 mm long, very narrow; short flight when disturbed		Thysanoptera: thrips	p. 107	
	b) Body > 2 mm long, variously shaped body and wings	8			
8	a) Forewings covered in minute scales that create unique colour patterns; hind wings may or may not have colour patterns		Lepidoptera: moths and butterflies	pp. 73-102	
	b) Forewings otherwise	9			
9	a) Wings held roof-like over body when at rest; may be clear, semi-transparent or with net-like venation; size variable	10			
	b) Wing position otherwise	12			
10	a) Tubular structures (cornicles) present on rear of abdomen; body up to 4 mm long		Hemiptera: winged aphids	pp. 59-70	
	b) Appearance otherwise	11			

Adult Characteristics

Line	Description of characteristics	Go to line	Order	Pest	Natural Enemy
11	a) Forewings semi-transparent, usually patterned; hop-like flight when disturbed; body 5–7 mm long		Hemiptera: leafhoppers	pp. 45-47	
	b) Lace-like transparent wings with net-like venation; greenish or brownish wing and body colour; may have long "neck"; body 10–20 mm long		Neuroptera: lacewings Raphidioptera: snakeflies		p. 139 p. 140
12	a) Transparent wings folded flat over body when at rest; size variable; egg-laying appendage (ovipositor) may extend from abdomen		Hymenoptera: Ichneumons, parasitic wasps, sawflies	p. 72	pp. 129-138
	b) Wings otherwise	13			
13	a) Forewings parchment-like, held flat over the body appearing overlapped; forewings parchment-like, held flat over the body and appearing overlapping, basal half with some patterning, outer half usually transparent; piercing and sucking mouthparts		Hemiptera: true bugs	pp. 48-58	pp. 124-128
	b) Wings otherwise	14			
14	a) Forewings parchment-like, somewhat transparent and folded along the body when at rest; membranous hind wings folded beneath forewings and may have some patterning; hind legs modified for jumping; chewing mouthparts		Orthoptera: grasshoppers, crickets	pp. 103-106	
	b) Forewings otherwise	15			
15	a) Forewings opaque, hard, shell-like, and meet over the centre line of the abdomen; may or may not extend to the end of the abdomen; transparent membranous wings may be present beneath; chewing mouthparts		Coleoptera: leaf beetles, weevils, ground beetles, lady beetles	pp. 17-34	pp. 115-117
	b) If no order selected, repeat the process				

Immature stages

Line	Description of characteristics	Go to line	Order	Pest	Natural Enemy
16	a) No obvious 3-segment body (head, thorax and abdomen); head and legs may be present; does not resemble any adult forms	17			
	b) Body appears to have 3 body segments and 3 pairs of legs; may or may not resemble adult insects	22			
17	a) Legless, maggot- or grub-like with no obvious head; mobility variable; feeds in or on insects or plants	18			
	b) Appearance otherwise	21			
18	a) Found in or on insects	19			
	b) Found on plants	20			
19	a) Very small, whitish grub-like (1 –3 mm); no distinctive head or body structures; found within or on a host insect		Hymenoptera: parasitic wasp larvae		pp. 129-138
	b) Small to moderate size, whitish found within host bodies; have a distinctive pair of dark openings (spiracles) at end of body		Diptera: tachinid fly larvae		p. 123
	c) Small to moderate size, somewhat flattened, maggot-shaped; various colours and patterns; two distinct breathing holes at end of body; found with aphid colonies		Diptera: syrphid fly larvae		p. 122
20	a) Small to moderate whitish maggots feeding in or on plant parts, usually roots		Diptera: root maggot larvae	pp. 35-44	
	b) Appearance and hosts otherwise	21			
21	a) Body fleshy, usually with distinctive markings; short and fleshy legs (prolegs) present under some or all of the abdominal segments	22			
	b) Body appearance otherwise; prolegs absent	23			

Immature stages

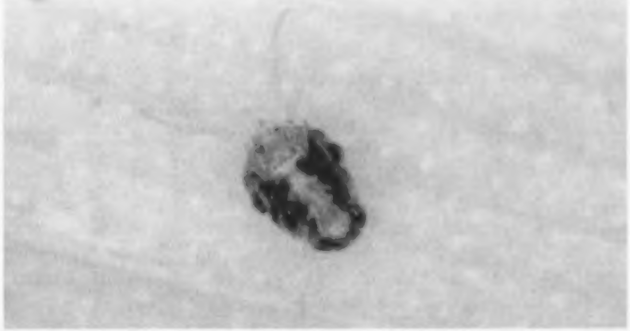
Line	Description of characteristics	Go to line	Order	Pest	Natural Enemy
22	a) Six or more pair of prolegs present		Hymenoptera: sawfly larvae	p. 72	
	b) Two to five pairs of prolegs; moves in a crawling or looping motion; chewing mouthparts; may curl up or drop on a fine silk thread when disturbed		Lepidoptera: moth and butterfly larvae	pp. 73-102	
23	a) Body somewhat hard, wiry; very short true legs; yellowish to orange colour; lives in the soil		Coleoptera: click beetle larvae – wireworms	pp. 33-34	
	b) Appearance otherwise	24			
24	a) Very small (<1 mm), orange-coloured, mobile, somewhat flattened oval body, reduced antennae; no wing stubs		Hemiptera: mealybug nymphs	p. 71	
	b) Appearance otherwise	25			
25	a) Small (1.5–2 mm long), variously coloured, soft-bodied, slow moving; two tubular structures (cornicles) extend from top of end of abdomen (various lengths); wings absent or reduced to stubs, never covering body; lives in colonies on plants; piercing and sucking mouthparts		Hemiptera: aphid nymphs	pp. 59-70	
	b) Appearance otherwise	26			
26	a) Small (1–2.5 mm long), somewhat narrow, pale coloured body, with pointed abdomen often tilted upward; appears to move slightly sideways when walking; piercing and sucking mouthparts		Hemiptera: leafhopper nymphs	pp. 45-47	
	b) Appearance otherwise	27			
27	a) Very small (1–1.5 mm), narrow, white or yellow coloured; somewhat fast moving, hiding among plant parts		Thysanoptera: thrips nymphs	p. 107	
	b) Appearance otherwise	28			

Immature stages

Line	Description of characteristics	Go to line	Order	Pest	Natural Enemy
28	a) Body with somewhat flattened, variously coloured, piercing and sucking mouthparts; wings vary in length according to nymphal stage (instar)		Hemiptera: true bug nymphs	pp. 48-58	pp. 124-128
	b) Appearance otherwise	29			
29	a) Small to moderate sized, laterally flattened, with hind legs modified for jumping; chewing mouthparts		Orthoptera: grasshopper and cricket nymphs	pp. 103-106	
	b) Appearance otherwise	30			
30	a) Body fleshy, grub-like, slight C-shaped posture; whitish colour; distinctive head and short legs; not very mobile; present in soil or in plant hosts		Coleoptera: weevil larvae	pp. 24-32	
	b) Appearance otherwise	31			
31	a) Body shape and mobility variable, abdomen often pointed, may be hump-backed; chewing mouthparts; antennae reduced; no wing stubs		Coleoptera: beetle larvae	pp. 17-23	
	b) If no group selected, repeat the process				

Potato aphid – adult, nymph
Joseph Berger, Bugwood.org

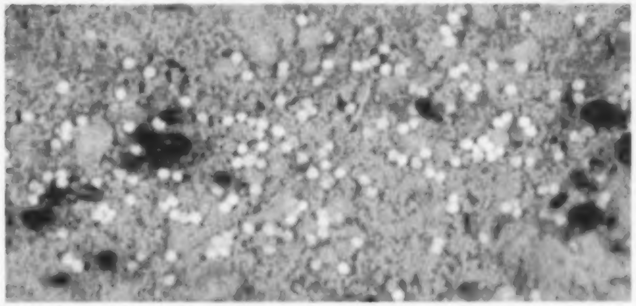
DESCRIPTIONS OF FIELD CROP PESTS



Brown wheat mite – adult closeup
Frank Peairs, Colorado State University, Bugwood.org

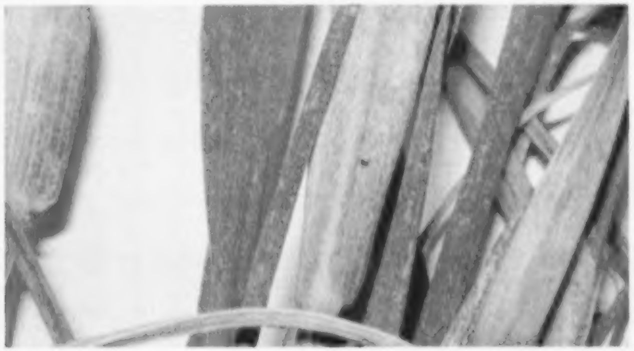
Mite, brown wheat

Petrobia latens Müller



Brown wheat mite – adults and eggs
Frank Peairs, Colorado State University, Bugwood.org

Brown wheat mite – stippling damage on leaves
Mary Burrows, Montana State University, Bugwood.org



Hosts

Wheat and barley are preferred cereals; other hosts include various vegetables, melons, strawberries, legumes and fruit.

Identification

ADULTS: 0.5 mm ovate brownish bodies with yellow to orange legs; front pair much longer than other three pair of legs. Lighter band down the midline of the body. Very mobile and drop from plants when disturbed.

LARVAE AND NYMPHS: Larval mites have only 3 pairs of legs; nymphal stages resemble adults but are smaller.

Life Cycle

Overwinter as white eggs in the soil under soil clods, stones, and plant debris. No males have been found. There are two or three generations in the spring before females begin to lay overwintering eggs in June. Some of these eggs may hatch in the fall if soil moisture is adequate, but most hatch the following spring.

Feeding Damage

ADULTS AND NYMPHS: Puncture tissue to feed on cell contents, giving plants a drought-stressed appearance (bronzed or yellowish colour, fine stippling) which is aggravated when crop is moisture stressed. The mite can also transmit the virus causing barley yellow streak mosaic. The virus infects both spring wheat and barley, reducing the yield of both; in barley, kernel weight and plumpness are also reduced. Characteristic symptoms include yellow to gray-white streaks on the leaves parallel to the leaf veins, stunting plants or killing them. Rainfall of 7–10 mm will reduce mite numbers and risk of damage. Infestations develop quickly under dry conditions.

Similar Species

Closely resembles the clover mite (*Bryobia praetiosa* Koch) which is found on some grasses, clovers and several ornamental plants but is not common on cereals. Unlike the two-spotted spider mite, neither the clover nor the brown wheat mite produces webbing.

Monitoring/Scouting

Scout young crops weekly for signs of injury and presence of mites, especially during dry conditions.

Economic Threshold

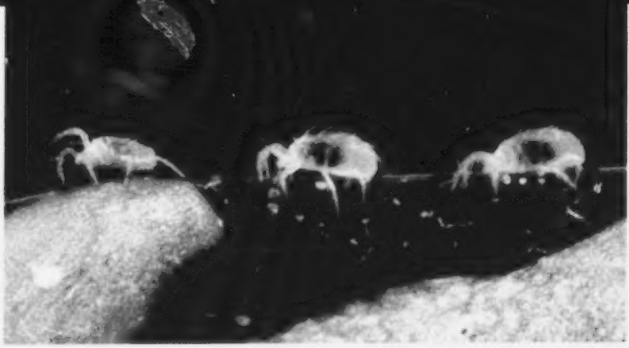
200 or more mites per 25 cm of row.

Management Options

BIOLOGICAL: Depending on crop and location, several species of predatory mites and insects feed on all stages of the mite (e.g. green lacewing, p. 139).

CULTURAL: Crop rotation with non-host crops. Eliminate volunteer wheat in the spring as food for newly hatched larvae and developing nymphs.

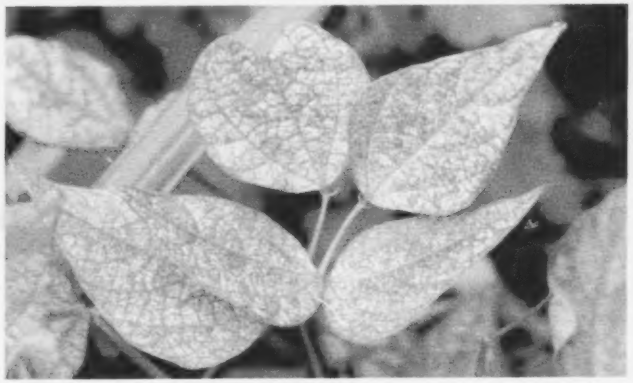
CHEMICAL: Consider if damage is obvious, threshold is reached, and plants are moisture stressed or poorly tillered.



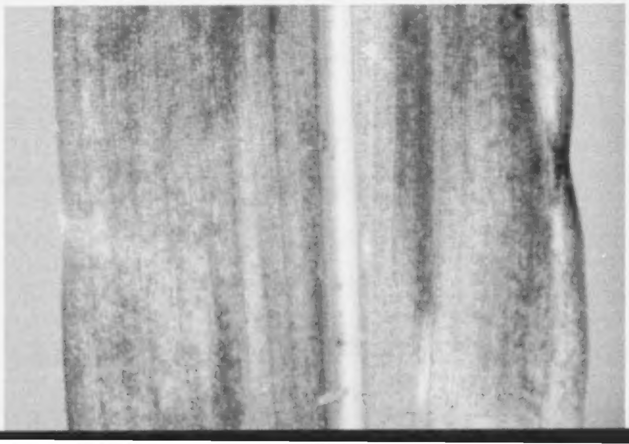
Twospotted spider mite – adult closeup
David Cappaert, Michigan State University, Bugwood.org

Mite, twospotted spider

Tetranychus urticae Koch



Twospotted spider mite – stippling damage on bean
Whitney Cranshaw, Colorado State University, Bugwood.org



Twospotted spider mite – stippling damage on corn
Daren Mueller, Iowa State University, Bugwood.org

Hosts

Corn, soybean, dry beans, alfalfa, vegetables, fruit trees, berries, herbaceous and woody ornamentals, and greenhouse crops.

Identification

ADULTS 0.5 mm long, eight legs, greenish, yellowish to orange oval body with two dark spots on their abdomen and eight legs. Visible to the unaided eye only as small specs.

LARVAE AND NYMPHS Larval mites have only 3 pairs of legs; nymphal stages have 4 pairs of legs and resemble adults, but are smaller and black spots are paler.

Life Cycle

Overwinter in protected sites as eggs, immatures or adults depending on food hosts and habitat. Immatures and adults move to emerging plant hosts in the spring and, depending on temperature and moisture conditions, produce many overlapping generations before seeking overwintering sites in the fall. They disperse by spinning a silk thread that's caught by the wind.

Feeding Damage

ADULTS AND NYMPHS Motile stages create webbing on the undersides of leaves where they puncture cells to feed on cell contents, causing stippling, yellowing or browning of leaves. Leaves may dry and drop which can further reduce crop yields. Infestations start at the field edge and move inwards. Extended hot, dry conditions favour rapid population build up and acerbate feeding injury. Dust from field roads drifting onto alfalfa plants favors spider mite flare-ups.

Similar Species

None.

Monitoring/Scouting

In dry, warm springs, examine host crops weekly along the margins adjacent to grassy areas, residential areas, production greenhouses and other areas mites may have overwintered. Check for feeding injury and characteristic webbing on undersides of leaves. Also check alfalfa regrowth when hot dry conditions persist.

Economic Threshold

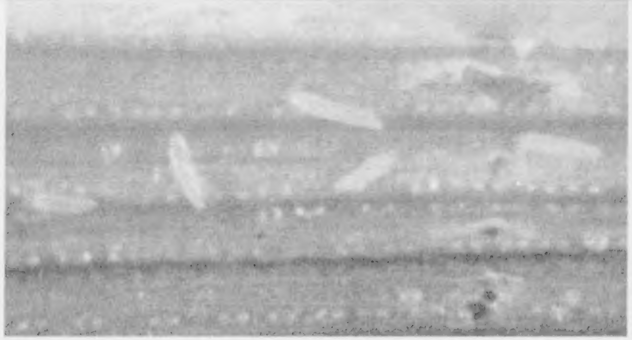
None established.

Management Options

BIOLOGICAL Depending on crop and location, several species of predatory mites and insects feed on all stages of the mite (e.g. green lacewing, p. 139).

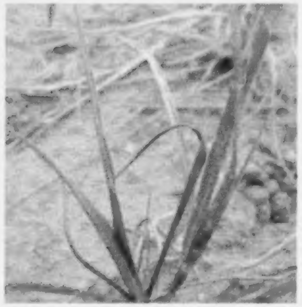
CULTURAL Minimizing plant stress through improved irrigation, fertilization, and cultural practices such as timely harvest is beneficial.

CHEMICAL Consider a spray if mites are numerous and plants are beginning to develop a bronzed appearance. A second spray may be required 7–10 days later to kill any mites that hatched from previously laid eggs. Border or spot sprays may be all that is needed. To avoid mite flare-ups, avoid using products against other pests that kill mite natural enemies.



Wheat curl mite – adult
Gary Hein, University of Nebraska

Mite, wheat curl
Aceria tosichella Keifer



Wheat curl mite – damage
Gary Hein, University of Nebraska

Hosts

Wheat most at risk to yield loss; barnyard grass, green foxtail, other cereals, and grasses are less susceptible.

Identification

ADULTS: 0.25 mm long, yellowish, cigar-shaped body with forward pointing legs. Can be seen with a 10–20 power hand lens.

LARVAE AND NYMPHS: Resemble adults but are smaller.

Life Cycle

Mites are spread by winds > 25 kph when temperature >18°C. The overlapping occurrence of winter and spring wheat, wild, and cultivated grasses provide available hosts for the survival of all life stages of this mite and the wheat streak mosaic virus throughout the year. Population growth slows in hot (>27°C), dry conditions.

Feeding Damage

ADULTS AND LARVAE: This mite is important because it transmits wheat streak mosaic virus. Large populations of mites on wheat will cause the leaf blades to curl upward and inward. The wheat streak mosaic virus causes leaves to turn yellow with green lines or splotches; damage most severe on older leaves. Infected plants may be killed, stunted, or have low to no seed set, depending on how early in development the plants were infected. The virus is transferred to mites through infected plants, not through the eggs to new generations.

Similar Species

The cereal rust mite, *Abacarus hystrix* (Nalepa), and another eriophyid mite, *Aculodes mckenziei* (Keifer), occur on cereals and grasses but are less common and damaging. They are difficult to distinguish without the aid of a microscope.

Monitoring/Scouting

Examine young plants for signs of feeding damage and examine damaged leaf tissue under a microscope for the presence of the minute mites.

Economic Threshold

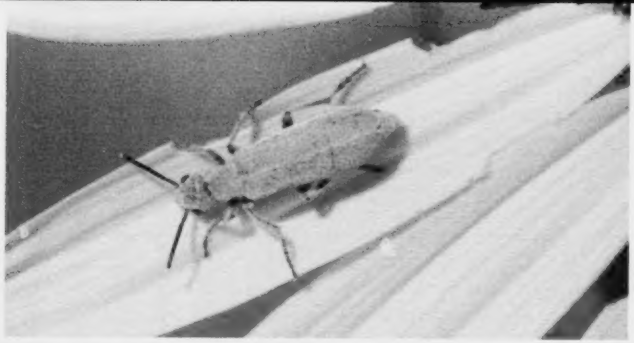
None established.

Management Options

BIOLOGICAL: Predaceous mites will feed on rust mites in the spring until larger host species emerge. Green lacewing (p. 139) may also prey on rust mites.

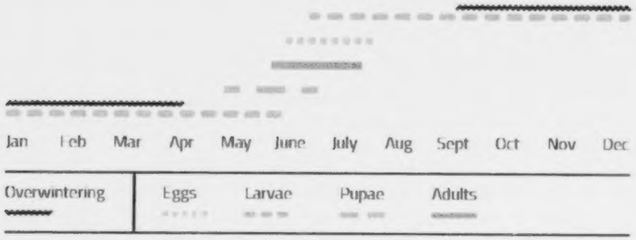
CULTURAL: Because this pest is dispersed by wind, it is important to control winter wheat and spring wheat volunteers and grass weeds at least 2 weeks prior to planting. The mite cannot survive more than 8–10 hours away from green plant tissue. Volunteer plants may contain some virus which will be picked up by the emerging mites. Mites can only survive on green tissue. In fields where the virus has caused damage, consider planting AC Radiant which is the only winter wheat variety with wheat curl mite resistance.

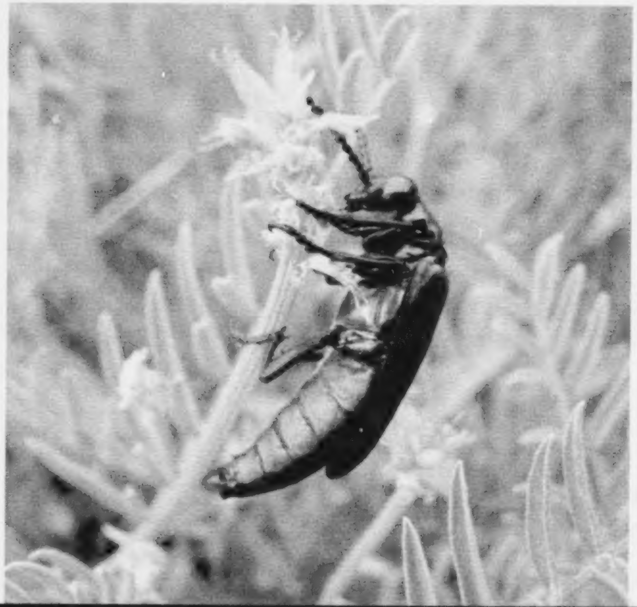
CHEMICAL: Insecticides/miticides are not effective because mites are in protected areas of plant and extremely fast rate of increase in populations.



Beetle, blister

Nuttall, *Lytta nuttalli* Say and *Epicauta* spp.





Blister beetle (*Epicauta* sp.) – adult
Whitney Cranshaw, Colorado State University, Bugwood.org

Hosts

ADULTS Alfalfa, broad beans, faba beans, canola, potato, sweet clover (low coumarin), sugar beets

LARVAE *Epicauta* spp. feed on grasshopper eggs. Nuttall blister beetle feeds in nests of ground-dwelling leaf-cutter and bumble bees.

Identification

ADULTS 12–25 mm long; elytra are flexible and thorax is usually narrower than the round head and elytra. Nuttall blister beetle adults are metallic green or purplish (16–28 mm long).

MATURE LARVAE About 13–25 mm long, mouthparts and legs generally reduced; pass through four soft-bodied forms during which mouthparts and legs gradually get smaller.

Life Cycle

Overwinter as larvae in the soil. Newly emerged adults congregate on food plants to feed and mate. Females lay four or five batches of 200–400 eggs in the soil which take 2–3 weeks to hatch. Most adults are present from early June to mid-August depending on species. One generation per year.

Feeding Damage

ADULTS Adults are frequently found in groups feeding and mating on flowering crops but rarely cause damage before moving on. However, blister beetles contain the toxin cantharidin. It can cause severe distress in sensitive livestock, especially horses, after eating baled alfalfa hay containing blister beetles.

LARVAE Do not feed on crops (see above).

Nuttal's blister beetle – adult
Laura Hubers, USFWS Moutain-Praine

Similar Species

Black coloured adults can be confused with ground beetles (p. 115) and adult mealworms which do not have the rounded head or thorax.

Monitoring/Scouting

None developed. Use a sweep net to collect adults congregating on plants.

Economic Threshold

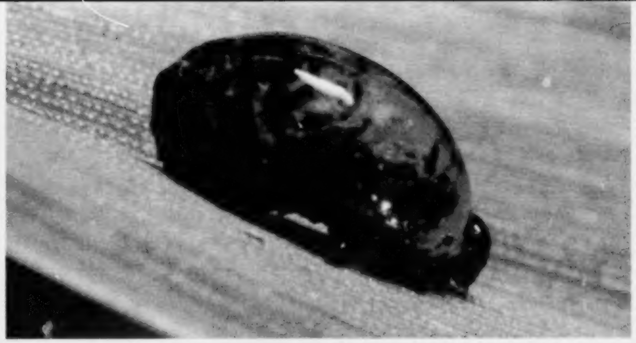
None established.

Management Options

BIOLOGICAL Blister beetle larvae of *Epicauta* spp. are useful predators of grasshopper eggs.

CULTURAL To avoid threats to livestock health, avoid harvesting adult beetles with alfalfa.

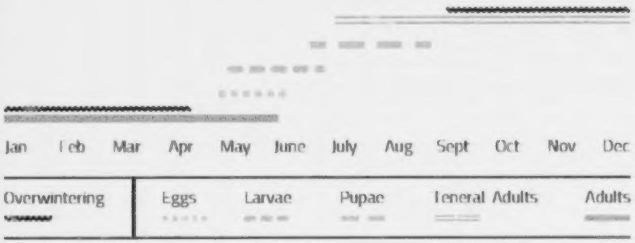
CHEMICAL Insecticides registered for alfalfa and sweet clover.

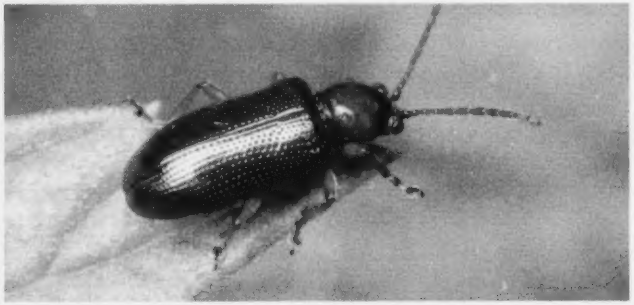


Cereal leaf beetle – larva
Alberta Agriculture and
Rural Development

Beetle, cereal leaf

Oulema melanopus (Linnaeus)





Cereal leaf beetle – adult
Boris Loboda

Cereal leaf beetle – damage
Bob Hammon, Colorado State
University, Bugwood.org

Hosts

Oats, barley, wheat (preferred), corn, triticale, reed canarygrass, ryegrass, rye, fescue, other grasses (brome, orchard, foxtail, blue, timothy, quack), wild oats, and millet.

Identification

ADULTS 6–8 mm long with reddish legs and thorax between metallic blue head and elytra.

MATURE LARVAE 4–5 mm long, hump-backed body covered in slimy faecal material.

Life Cycle

Adults overwinter outside fields under plant material, tree bark, building siding, and other protected sites. Each female lays 50 to 275 yellowish orange oval eggs singly or in batches of 3–4 touching end to end on the upper surface of leaves. Larvae feed for 2–3 weeks then drop to the ground to pupate in earthen cells for about 3 weeks. New adults feed for 2–3 weeks before seeking overwintering sites. One generation per year.

Feeding Damage

ADULTS Feed on upper tissue between veins, causing uniform longitudinal incisions, but little if any economic injury.

LARVAE Feed on the upper surface leaf tissue causing elongated window pane-like damage. The rate of feeding damage increases as larvae mature. Yield quality and quantity is decreased if the flag leaf is stripped. Severely damaged crops have frosted appearance.

Similar Species

Collops spp. are similar in appearance and size. These beneficial insects have a dark elytra often with orange to reddish thorax; elytra also have hairs which are absent in the cereal leaf beetle. The first segment of first 2 pairs of legs and the basal segment of the antennae are also reddish in colour. The leaf beetle, *Gastrophysa polygoni* (Linnaeus), also resembles the cereal leaf. It measures about 5 mm long and is green-blue in colour with an orange thorax and metallic green elytra.

Monitoring/Scouting

Beginning just before the boot stage, examine 10–20 plants at 5 sites following a "W" pattern across the crop, beginning from a field margin. Calculate the average number of larvae and eggs/plant for the crop.

Economic Threshold

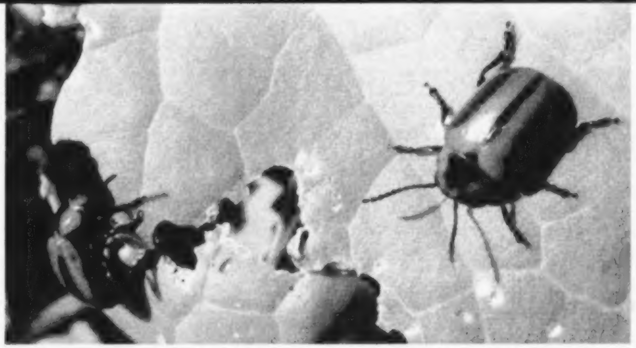
Pre-boot stage: 3 eggs and larvae or more per plant, including all the tillers present before flag leaf emergence. At the boot stage: 1 larvae or more per flag leaf.

Management Options

BIOLOGICAL The introduced larval parasitoid, Tetrastichus julis (Walker) (p. 134), has successfully reduced and maintained populations below economic levels. Lady beetles also feed on larvae. Dissect mature larvae for the presence of small yellowish parasite larvae to determine if *T. julis* is present.

CULTURAL Optimize crop development (nutrition management) to reduce impact of larval feeding.

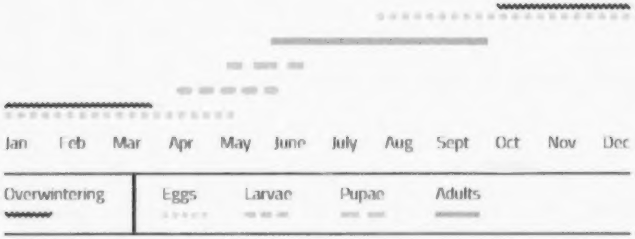
CHEMICAL Apply recommended products if warranted. If *T. julis* found, leave up to 1 acre unsprayed in one or two corners adjacent to a shelterbelt and/or water body to allow the parasitoid to multiply.

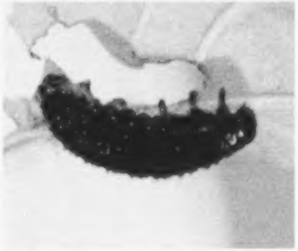


Red turnip beetle – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development

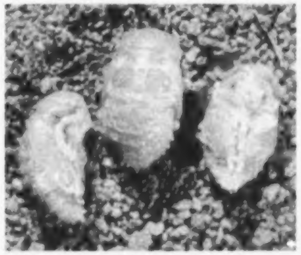
Beetle, red turnip

Entomoscelis americana Brown





Red turnip beetle – larva
AAFC



Red turnip beetle – pupa
AAFC

Hosts

Canola, mustards, cole crops, and cruciferous weeds (but not stinkweed).

Identification

ADULTS: 7-10 mm long, distinctive red body with black markings on head and thorax and three black lines down back.

MATURE LARVAE: 10-12 mm long, hump-backed, slow moving.

Life Cycle

Overwinters as reddish brown oval eggs in the soil. Mature larvae form bright orange bare pupae in earthen cells. Newly emerged adults feed for 2–3 weeks and then enter the soil to escape the summer heat for about a month. Upon emergence they disperse by flying throughout the crop and to other host crops to mate and lay eggs (300–400/female) at the base of host plants. One generation per year.

Feeding Damage

ADULTS: When adults consume volunteer hosts at their emergence sites, they walk to nearby host crops. Moving in from the field margins in a band, they feed on host seedlings causing delayed harvest or need for re-seeding to replace killed plants. Later in the season they feed on leaves, stems and pods. Attacked pods are prone to premature shelling.

LARVAE: Feed on volunteer host plants in the spring.

Similar Species

None.

Monitoring/Scouting

In April and May, inspect previously infested fields for larvae feeding on volunteer crop and weed hosts. Monitor the margins of nearby host crops nearest previously infested fields for the first 2 weeks after crop emergence for presence of invading adults.

Economic Threshold

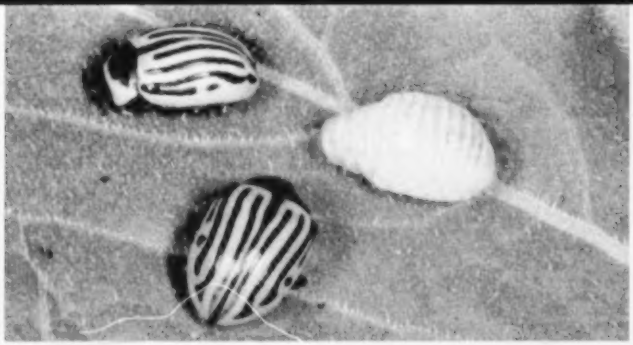
None established.

Management Options

BIOLOGICAL: No specific natural enemies identified – see also Integrated Pest Management (IPM) section (p. 3).

CULTURAL: Rotate host and non-host crops; cultivate infested fields in late fall or early spring to bury eggs, make it difficult for hatching larvae to emerge, and to eliminate volunteer food hosts for any emerged larvae. Late spring cultivation will reduce pupal survival by crushing, predation, and desiccation. Avoid under seeding non-host crops with canola which can provide a source of beetles the following year to invade nearby host crops.

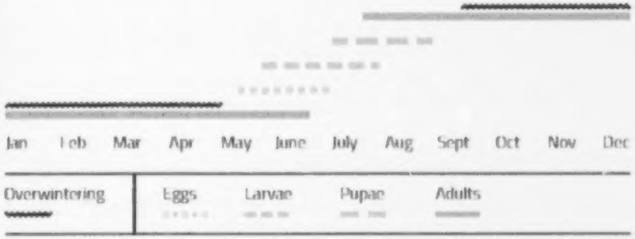
CHEMICAL: No insecticides registered.



Sunflower beetle – adult, larva
Frank Peairs, Colorado State University, Bugwood.org

Beetle, sunflower

Zygogramma exclamationis (Fabricius)



Hosts

Wild and cultivated sunflower.

Identification

ADULTS 6-8 mm long with 4 dark stripes on each elytron, the fourth of which ends at the middle of the elytra in a small dot that resembles an exclamation point.

MATURE LARVAE 8-10 mm long, yellowish-green with brown head, hump-backed, slow-moving.

Life Cycle

Adults overwinter in the soil and emerge as sunflowers begin to emerge in the spring. Each female lays up to 1000 eggs singly on leaves and stems. Mature larvae drop to the ground to form bare, yellow pupae in earthen cells. Newly emerged adults feed for about a month before digging into the soil to overwinter. One generation per year.

Feeding Damage

ADULTS Feed on emerging sunflower seedlings in the spring and uppermost leaves (bracts) in the late summer.

LARVAE Feed on leaves at night, hiding under flower bud bracts and in leaf axils during the day.

Similar Species

Adults closely resemble adult Colorado potato beetles (*Leptinotarsa decemlineata* (Say)). However, sunflower beetles are smaller, Colorado potato beetles do not feed on sunflowers, and sunflower beetles do not feed on potatoes. Adults also resemble adult cottonwood leaf beetle (*Chrysomela scripta* Fabricius) which has broken lines down its back and a broad black band down its thorax.

Monitoring/Scouting

ADULTS (May–June): examine 10 seedlings at 2 locations on each side of a field with 2 sampling sites near the centre.

LARVAE (July to mid-Aug.): examine 10 plants at least 5 sites by pealing back bracts around the flowers; record total number of larvae found and plants examined to calculate average/plant.

Economic Threshold

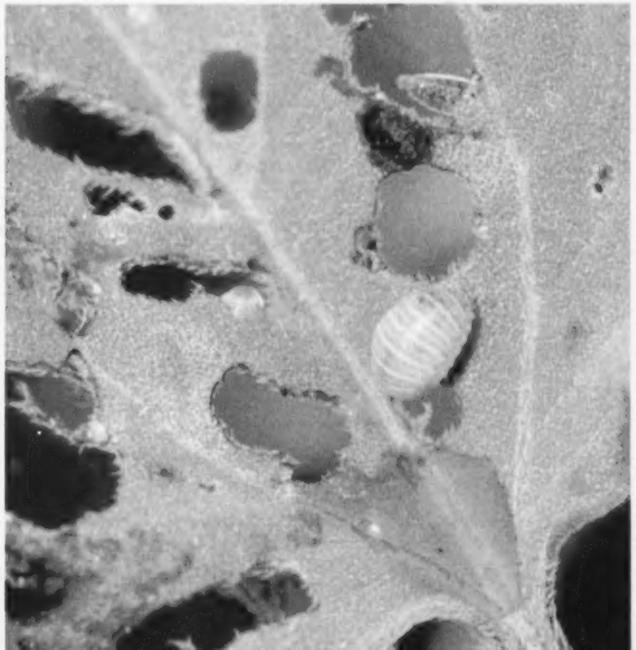
1-2 adult beetles/seedling at the 2-6 leaf stage or 10-15 larvae per plant during the summer.

Management Options

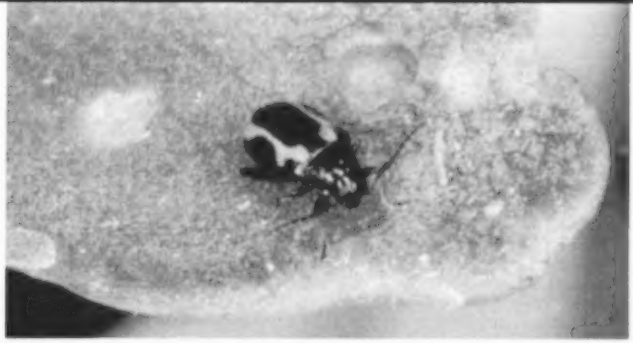
BIOLOGICAL Natural enemies can often keep populations below damaging levels. Parasitoids attack all stages (e.g. the pteromalid wasp, *Erixestus winnemana* Crawford). The tachinid flies *Myiopharus macellus* (Reinhard) and *M. doryphorae* (Riley) are important natural enemies of the larvae. Ladybird beetles feed on eggs; green lacewing larvae feed on both eggs and larvae; damsel bugs and the twospotted stink bug (*Perillus bioculatus* (Fabricius)) feed on the larvae.

CULTURAL Delayed planting may decrease populations.

CHEMICAL A single spray should provide satisfactory control if required.



Sunflower beetle – larva, damage
Whitney Cranshaw, Colorado State University, Bugwood.org



Striped fleabeetle – adult, damage
Mike Dolinski, MikeDolinski@hotmail.com

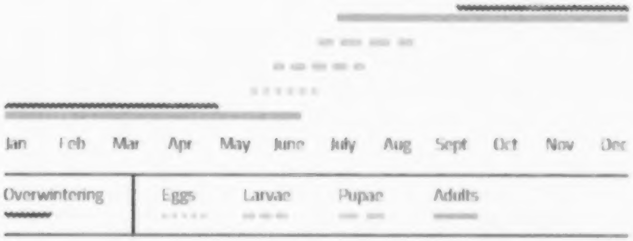
Flea beetles

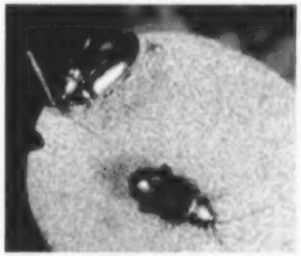
crucifer flea beetle

Phyllotreta cruciferae (Goeze)

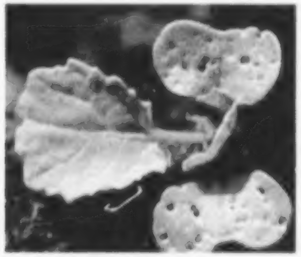
striped flea beetle

Phyllotreta striolata (Fabricius)





Crucifer fleabeetle – adult, damage
AAFC



Fleabeetle – damage
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

Canola, mustard, and related cruciferous plants and weeds.

Identification

ADULTS 2–3 mm long, oval; crucifer flea beetle is shiny bluish black; striped flea beetle is black with two wavy yellow lines along back. Jumps like a flea when disturbed .

MATURE LARVAE Up to 6 mm long with whitish, slender body, brown head and anal plate, and 3 pair thoracic legs.

Life Cycle

Overwinter as adults under plant material along field margins. Females lay eggs in the soil near host plants in batches of about 25. Larvae feed for 3–4 weeks then pupate in earthen cells. New adults feed on host plants until seeking overwintering sites in September.

Feeding Damage

ADULTS Feed on cotyledons and first true leaves in spring creating a shot-hole appearance; also feed on seedling stems under windy, damp conditions causing breakage or wilting. Feed on bark of maturing pods in late summer; premature ripening under high populations.

LARVAE Feed on roots of host plants with minimal impact on plants.

Similar Species

Many other species of flea beetles that are not pests of cruciferous crops are present in western Canada; some species have been introduced for biological control of weeds.

Monitoring/Scouting

Starting from field margins, examine emerging plants in spring for shot-hole feeding damage to cotyledons. Cease monitoring after second true leaves appear or adult activity ceases.

Economic Threshold

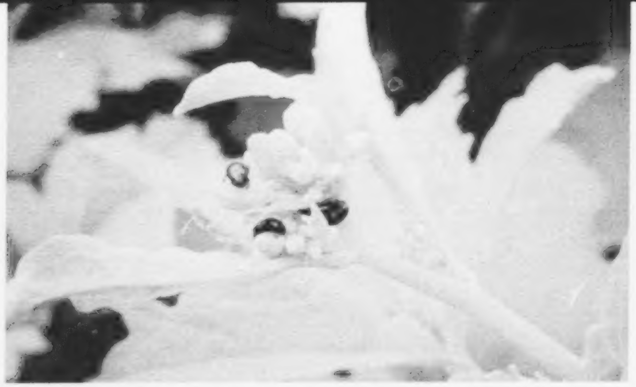
Consider foliar treatments when 25% cotyledon leaf damage and adults are present. Use a lower threshold under hot, dry conditions which slow seedling development and prolong exposure of plants to attack.

Management Options

BIOLOGICAL Specific natural enemies are not known that can regulate pest populations.

CULTURAL Eliminate volunteer host plants (including cruciferous weed hosts) in the spring where possible. Use good quality seed and plant seed to optimize germination and vigorous seedling development to lessen impact of flea beetle feeding. Consider adjusting seeding rates to reduce risk of damage (conventional tillage—10 g seed/ha and 25 cm row width; zero till, 8 kg seed/ha). Damage is less with zero tillage than conventional tillage.

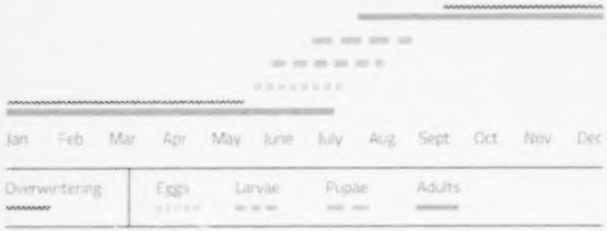
CHEMICAL Apply foliar treatments if seed treatments fail to protect young plants, especially when plant development is delayed.

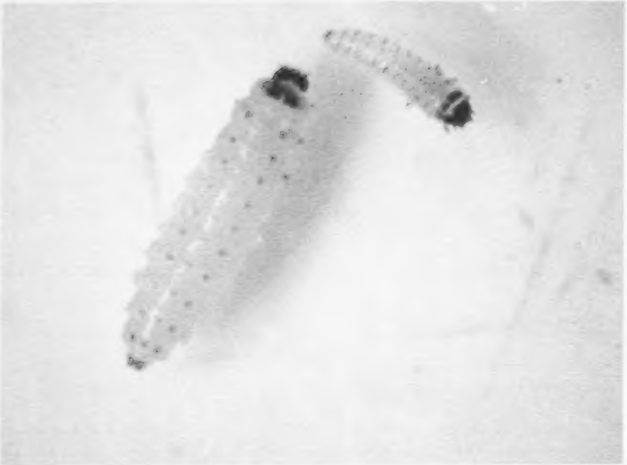


Pollen beetle – adult
C. Noronha, AAFC

Pollen beetle, Bronzed blossom

Brassicogethes viridescens (Fabricius)





Larva beetle – larva
C. Noronha, AAFC

Hosts

Canola and oilseed rape (*Brassica* spp.), mustards (*Brassica* spp., *Sinapsis* spp.), bittercress (*Sinapis* spp.), rockcress (*Arabis* spp.), wild radish (*Raphanus* spp.) and dogmustard (*Erucastrum* spp.). Not known to be established in Western Canada but present in Nova Scotia, PEI, and Quebec.

Identification

ADULTS: 2-2.5 mm long elongate-oval body with orange-yellow mouthparts and legs; metallic green to blue or brownish-red elytra (wing covers); antennae are clubbed (last segments swollen) with yellowish basal segments.

MATURE LARVAE: 4 mm long, grayish-white with black head; two small black spots on top of each abdominal segment.

Life Cycle

Adults overwinter in the soil under plant debris and can aggregate in nearby forested areas. They become active when air temperature reaches about 15°C in the spring. They will fly up to 3 km in search of host plants that are in bud through bloom stage. Female can lay up to 250 oval white eggs during their life span in small clusters of 2-3 eggs in the developing buds. Eggs hatch after about 12 days and larvae enter developing flower buds to feed. Larvae have two instars over 20-30 days before dropping to the ground to pupate in the soil. Adults emerge after about 4 weeks and feed on the pollen of other host plants before seeking overwintering sites in late summer. One generation per year.

Feeding Damage

ADULTS: Feed on buds, developing flower parts, and pollen of crop hosts; also feed on pollen of several non-crop hosts in the spring and prior to overwintering.

LARVAE: First instar larvae feed inside buds on pollen and second instar feed on pollen in open blossoms. Seed production can be reduced up to 70% by larval and adult feeding damage. Plants may compensate but seed is smaller and less mature at harvest (green seed).

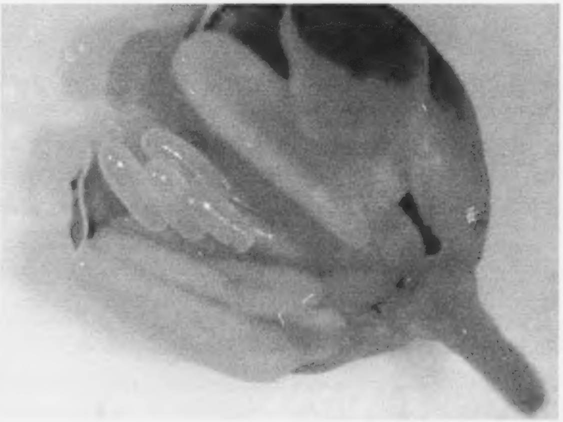
Similar Species

The rape pollen beetle (*Brassicogethes aeneus*) closely resembles *B. viridescens* in life cycle, appearance and damage. However, *B. aenus* adults are mainly shiny black with a hint of metallic green, legs are black and the basal antennal segments are not yellow. It also emerges about 2-3 weeks earlier in the spring as it becomes active at 11°C.

Monitoring/Scouting

During canola bud development and bloom (stages 3 and 4), at 5- to 7-day intervals, count the number of beetles on the budding shoots of 10 plants along five transects (at least 30 m long) from the crop margin towards the centre. Divide the total beetles observed by the number of shoots sampled to determine average beetles/shoot. Also calculate the number of plants/m^2 for each transect.

Note: this is only a potential pest and has not yet been found in Western Canada.



Pollen beetle – clutch of eggs
C. Noronha, AAFC

Economic Threshold

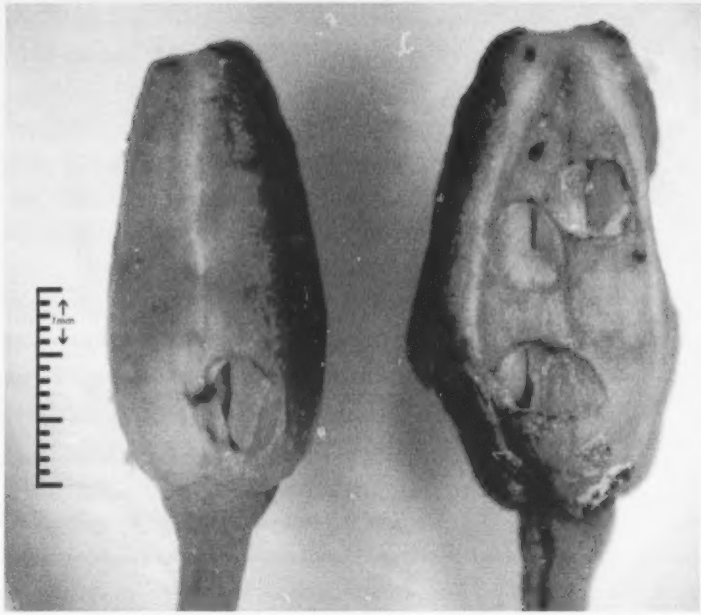
None have been developed for Western Canada. In Denmark, the threshold is 0.2-3 beetles per plant depending on precipitation (lower threshold for lower moisture). In Britain the threshold varies according to budding shoot density (from 7 beetles/shoot at 70 plants/m^2 to 25 beetles/shoot at 30 plants/m^2.

Management Options

BIOLOGICAL: Ground beetles are reported as predators of both adults and larvae. In Britain parasitic wasps cause up to 50% larval mortality in unsprayed crops.

CULTURAL: Eliminate potential infestations sources/alternate hosts such as volunteer canola and mustards.

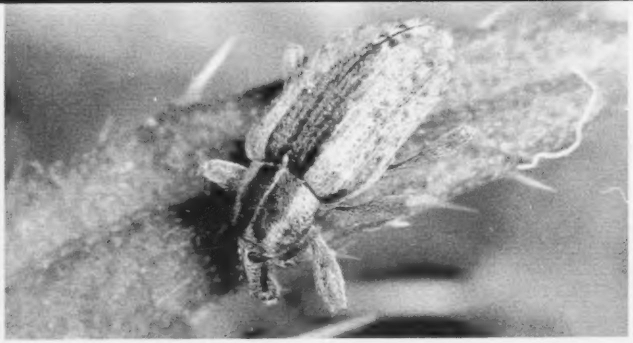
CHEMICAL: None registered in Canada.



Pollen beetle – damage
C. Noronha, AAFC

Pollen beetle in canola
C. Noronha, AAFC

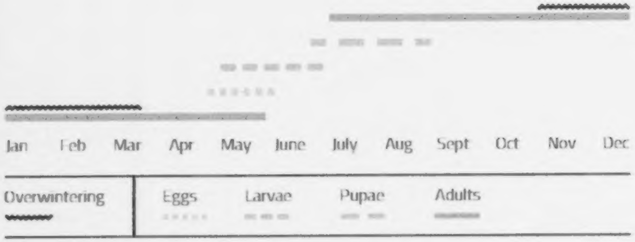
Note: this is only a potential pest and has not yet been found in Western Canada.

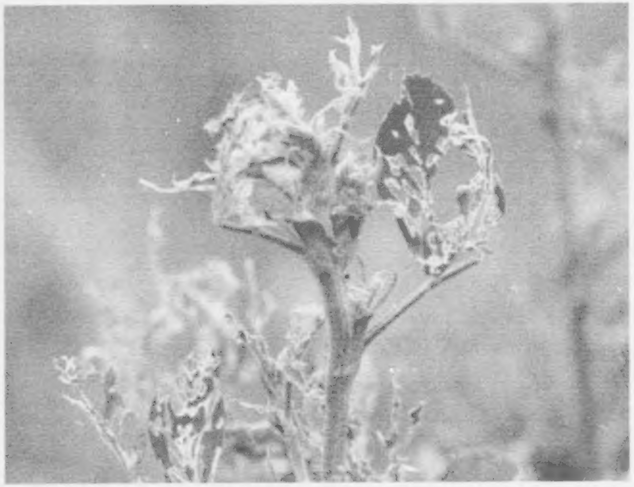


Alfalfa weevil – adult, damage
Boris Loboda

Weevil, alfalfa

Hypera postica (Gyllenhal)





Alfalfa weevil – damage
Whitney Cranshaw, Colorado State University, Bugwood.org

Hosts

Alfalfa; occasionally on vetches and clovers.

Identification

ADULTS: 4-5 mm long, with weevil snout and characteristic dark brown stripe from front of head down the middle for 2/3 of the body. Play dead when disturbed.

MATURE LARVAE: Up to 10 mm long with black head and white stripe down body.

Life Cycle

Overwinter as adults under plant material along field margins and fly into host crops to mate and feed in April–May; during May lay up to 600–800 shiny yellow to brown eggs in batches of 5-25 in plant stems or in leaf litter. Eggs hatch in 4-21 days and larvae feed for 3-4 weeks (peak mid-June to mid-July) then begin to pupate late June or early July in earthen cells. New adults feed on host plants until seeking overwintering sites. One generation per year.

Feeding Damage

ADULTS: Do not cause significant crop injury; feed on developing plants in spring and again in mid to late summer; notched leaves characteristic damage.

LARVAE: Young larvae feed within stem for 3–4 days then move to feed on developing tips and buds folded terminal leaves; older larvae skeletonise upper leaves giving crop a frosted appearance.

Similar Species

See Clover leaf weevil, Brachypera zoilus (Scopoli) (p. 26).

Monitoring/Scouting

HAY CROPS: Collect 30 stems in an M-shaped pattern. Beat stems inside a pail to knock off larvae. Count larvae and determine average height of alfalfa.

SEED CROPS: Assess percent of tips showing damage, or do 90 degree sweeps with a sweep net.

Economic Threshold

HAY CROPS: <30 cm plant height, 1 larva/stem; <40 cm plant height, 2 larvae/stem; 3 larvae per stem requires action regardless of height of crop.

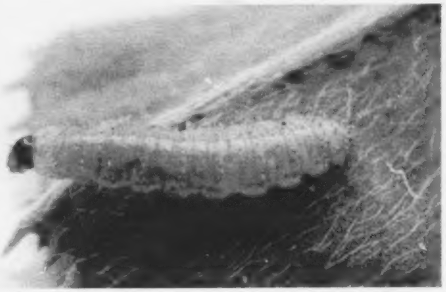
SEED CROPS: 20-25 larvae/sweep or 35-50% leaf tips showing damage.

Management Options

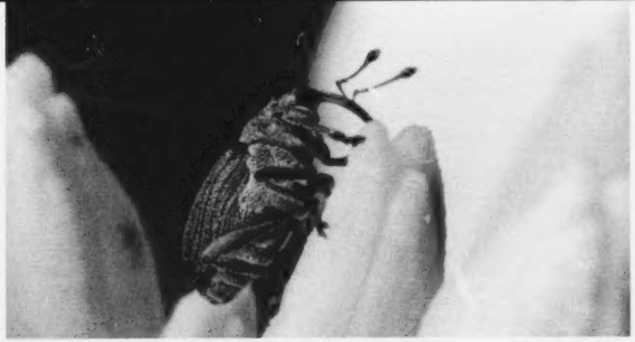
BIOLOGICAL: Parasitic wasp, *Bathyplectes curculionis* (Thomson) and *B. anurus* (Thomson) are important larval parasitoids. There are several more species of larval and egg parasitoids and predators.

CULTURAL: If possible, make first cut early. Check re-growth for larvae or damage.

CHEMICAL: Foliar sprays applied against larvae prior to first cut if required; post-harvest, check re-growth for larvae or signs of feeding damage and re-apply if necessary.



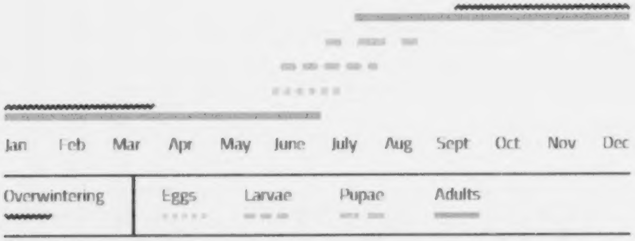
Alfalfa weevil – larva
Alberta Agriculture and Rural Development

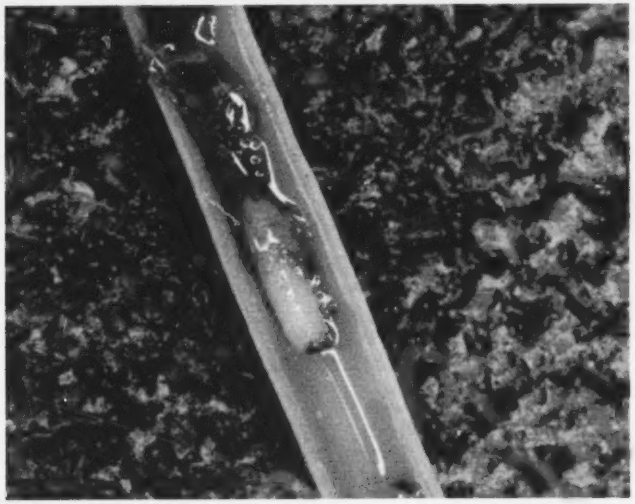


Cabbage seedpod weevil – adult
Alberta Agriculture and Rural Development

Weevil, cabbage seedpod

Ceutorhynchus obstrictus (Marsham)





Cabbage seedpod weevil – larva
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

TRUE (LARVAL) HOSTS: Canola, brown and wild mustard

ADULT HOSTS: Cole crops and flixweed, stinkweed, and hoary cress. Yellow mustard is not a host.

Identification

ADULTS: 3-4 mm long, with long narrow snout. Play dead when disturbed.

MATURE LARVAE: 2-3 mm long with whitish body, brown head and anal plate, and 3 pairs of thoracic legs.

Life Cycle

Adults overwinter under plant material along field margins and emerge beginning in April to feed and mate; females lay up to 250 eggs in pods, usually only one egg is laid/pod. Larvae feed for about 6 weeks then drop to the ground to pupate in earthen cells. One generation per year.

Feeding Damage

ADULTS: Cause bud-blasting from feeding on developing flower buds and young flowers which generally does not affect yields. Adults will also feed on pods in late canola crops.

LARVAE: Feed on developing seeds (up to 5/larva over 2–3 week life span); infested pods are more susceptible to shattering and fungal infections that further reduces marketable yields.

Similar Species

Ceutorhynchus neglectus Blatchley—smaller weevil (2–3 mm) present at same time on canola.

Monitoring/Scouting

From early bud stage through flowering, take ten 180° sweep net samples at ten sites following a "W" pattern across the field from a field margin.

Economic Threshold

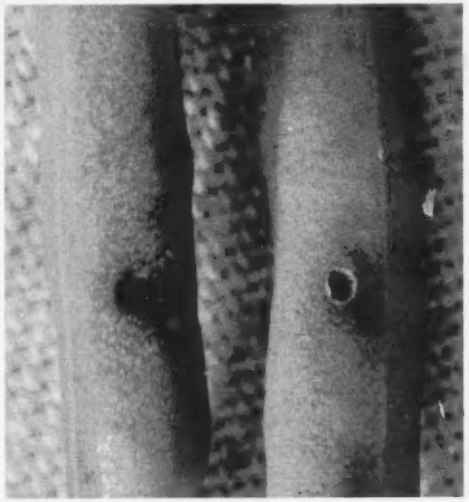
3–4 adults/sweep.

Management Options

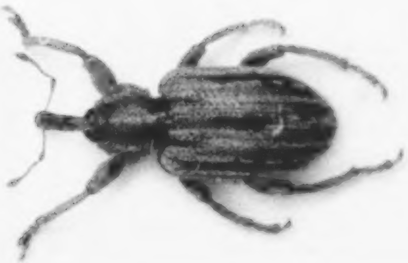
BIOLOGICAL: Minimal impact on populations. Two species of parasitoids: *Microctonus melanopus* (Ruthe), a wasp that parasitizes adult weevils (p. 130); and Trichomalis perfectus (Walker), a wasp that attacks weevil larvae within the pods (p. 137).

CULTURAL: Plant a trap crop of an earlier flowering canola variety, or seed a trap crop of the same variety 7–10 days earlier in order concentrate emerging adults along field margins for more efficient insecticide treatment if warranted.

CHEMICAL: For best results, make first treatment when the crop is in 10-20% flower (70% of plants have minimum 3-10 open flowers) to reduce egg laying in newly formed pods. Spray later in the day when bees and other beneficials are less active.



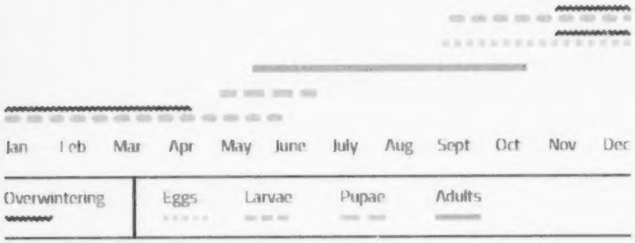
Cabbage seedpod weevil – damage
Mike Dolinski, MikeDolinski@hotmail.com



Clover leaf weevil – adult
Boris Loboda

Weevil, clover leaf

Hypera zoilus (Scopoli)



Hosts

Alfalfa, clover.

Identification

ADULTS: 5-10 mm long with snout with mottled colouration.

MATURE LARVAE: 12-13 mm long, green body with brown head and white stripe down the back.

Life Cycle

Overwinters as young larvae in the soil (some eggs may also overwinter). Females lay eggs in stems, on stalks or near the crowns of host plants. One generation per year.

Feeding Damage

ADULTS: Feed at night, notching the leaf margins similar to alfalfa weevil but no economic injury.

LARVAE: Generally not an economic threat. However, crops with heavy residue cover are more at risk to crop damage as larvae feed on emerging plants (skeletonise leaves, terminals), stunting growth and delaying development. Damage is most severe during late, cool, dry springs.

Similar Species

Larvae resemble alfalfa weevil larvae (p. 24) which have a black rather than brown head. Adult alfalfa weevil have a dark brown band down the back which is absent in adult clover leaf weevils which are much larger.

Monitoring/Scouting

When crowns appear, examine 20 plants at 5 sites following a "W" pattern across the crop, beginning from a field margin. Calculate the average number of larvae /crown for the crop.

Economic Threshold

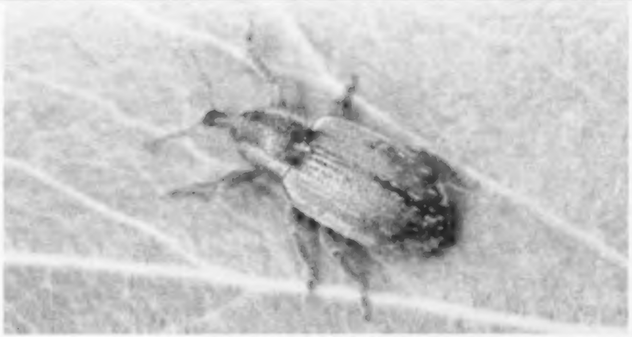
Five or more larvae/crown. Larval populations rarely reach this level.

Management Options

BIOLOGICAL: During wet or humid weather, many larvae are killed by a fungal disease. Infected larvae turn yellow and then brown.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

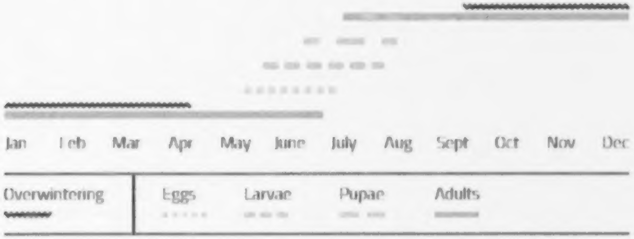
CHEMICAL: There is no registered control product for this species as it is not considered an economic pest.

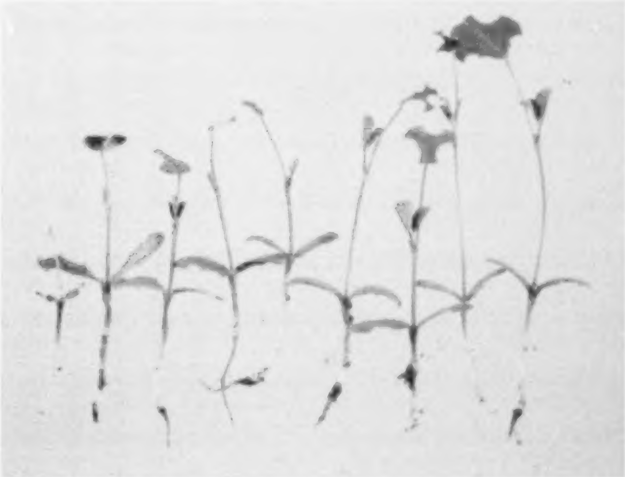


Lesser clover leaf weevil – adult
Boris Loboda

Weevil, lesser clover leaf

Hypera nigrirostris (Fabricius)





Lesser clover leavf weevil – damage
AAFC

Hosts

Red clover is preferred host, but white, alsike, and other clovers are also attacked.

Identification

ADULTS About 4 mm long with snout almost as long as its thorax; overwintered adults have blue-green tinge; newly emerged summer adults are pale brown then gradually darken. Markings include 3 pale lines down the length of the thorax and 6 pale broken lines and a pale band along each side of the elytra.

MATURE LARVAE 6 mm long, somewhat "C"-shaped, grayish to brownish yellow with a brown head; legs greatly reduced.

Life Cycle

Overwinter as adults under soil debris in host crops and nearby vegetated areas. Eggs are laid in plant tissue. Larval numbers peak about the time red clover reaches full bloom. Pupation occurs on the plants in silken cocoons in the flower heads, leaf axils, or in the crown area.

Feeding Damage

ADULTS Feed at night on leaves and leaf buds creating characteristic rounded notches on leaf margins. Feeding does not affect forage yields. Summer adults feed for a short time before seeking overwintering sites.

LARVAE Feed on stipules, buds, and flower heads, often preventing the heads from forming, reducing seed yields, especially in dry years.

Similar Species

Clover leaf weevil is twice as large (p. 26) and the alfalfa weevil (p. 24) does not have the broken lines down the body.

Monitoring/Scouting

Inspect areas where flowers are sparse for the presence of larvae.

Economic Threshold

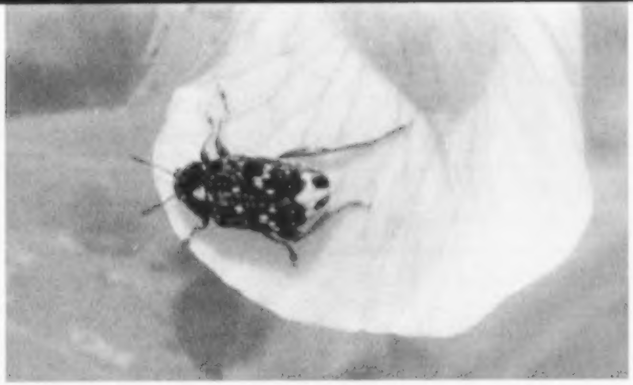
None. Larval densities greater than 3 larvae/ 5 shoots can damage 50% of the buds and flowers.

Management Options

BIOLOGICAL Many natural enemies and diseases help suppress populations.

CULTURAL Burning of red clover fields in the spring (where permitted) may decrease adult numbers but will also reduce important natural enemies.

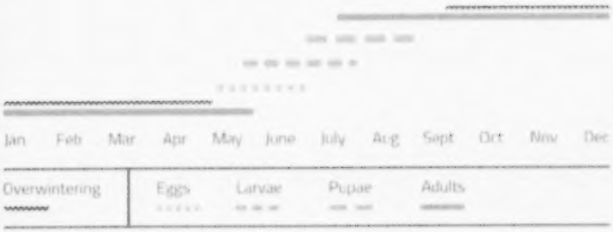
CHEMICAL Difficult to control with insecticides. If the weevil has caused economic damage the previous year, apply an insecticide against the spring adults before they lay eggs, or after pre-bud when newly hatched larvae are moving up to the buds and flowers.



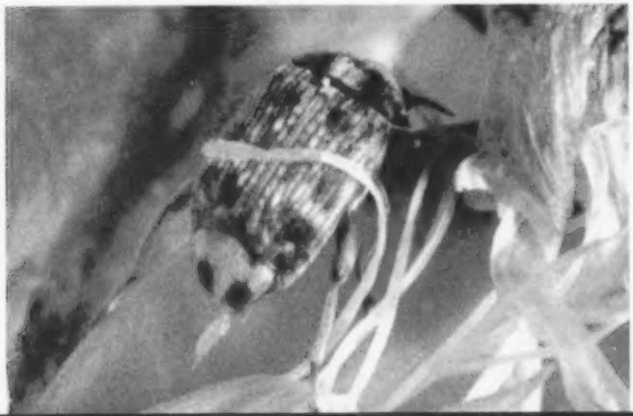
Pea weevil – adult
cc by-nc 3.0 Mariusz Sobieski, Bugwood.org

Weevil, pea

Bruchus pisorum (Linnaeus)



Pea weevil – adult laying egg
Ken Gray Image, Courtesy of Oregon State University



Hosts

LARVAL HOSTS: Field pea seed.

ADULT HOSTS: Pollen and petals of pea, alfalfa, clover, dandelion, bittercross, shepherd's-purse, scentless chamomile, and common plantain. Not known to be established in Western Canada. It is found in Idaho, Montana, and Washington, USA.

Identification

ADULTS: Stout, oval-shaped, 4–5 mm long brownish body marked with grey, black and white flecks and a distinctive triangular white spot at the base of the pronotum (i.e. plate-like structure covering the thorax). The exposed tip of the abdomen is white with two black oval spots. This pest is not actually a weevil as it lacks the typical extended weevil snout.

MATURE LARVAE: Curved, grub-like, white to cream-coloured body up to 6 mm long with brown head and mouthparts; legs are greatly reduced and appears legless.

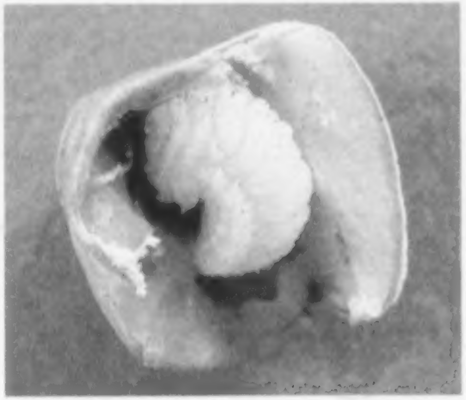
Life Cycle

Overwinter as adults in areas adjacent to previous pea crops, under tree bark, posts, along fence lines, around buildings, etc. They become active in the spring when air temperature reaches around 20°C. They can fly several kilomeers in search of pea crops that are in bud through to blooom stage. Each female lays up to 220 orange1.5 mm long oval eggs singly or in pairs on the outside of developing pods. Eggs hatch in 8–9 days. Larvae eat through the pod wall to enter the developing peas. Larvae feed for 5–6 weeks before pupating inside the pea seed. Adults are ready to emerge in 1–3 weeks and may leave the pea seed immediately or remain inside all winter to emerge the following season (mid-summer) after planting. Note: Adults that overwinter inside pea seeds are considered storage pests (see www.grainscanada.gc.ca/storage-entrepose/pip-irp/pip-irp-eng.htm). Large populations can literally reduce stored peas to dust if storage temperatures are warm enough to promote activity. Only one generation per year (55–66 days from egg to adult).

Feeding Damage

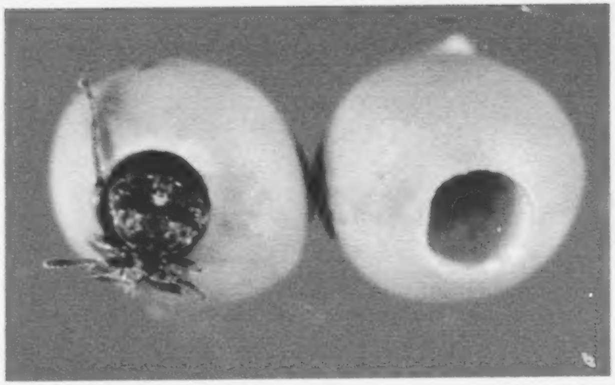
ADULTS: Create a 3 mm diameter emergence hole in pea seed.

LARVAE: Feed inside pea seeds (one larva per seed), often consuming the entire contents rendering peas unmarketable for human consumption and reducing harvested seed weight, germination and feed value for livestock.

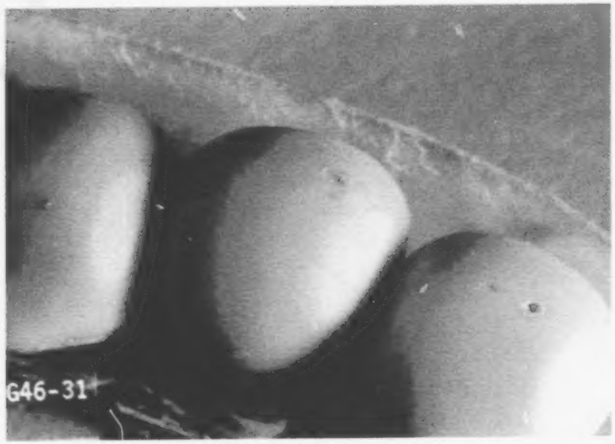


Pea weevil – larva inside seed
© Western Australian Agriculture Authority

Note: this is only a potential pest and has not yet been found in Western Canada.



Pea weevil – damage, emerging adult
© Western Australian Agriculture Authority



Pea weevil – damage, larval entry wounds
Ken Gray Image, Courtesy of Oregon State University

Similar Species

Unlikely to be confused with other pests of peas such as the pea leaf weevil (*Sitona lineatus* (Linnaeus) (p. 30)) which lacks the grey, black and white flecks.

Monitoring/Scouting

During bloom and before pod formation, use a sweep net at 5- to 7-day intervals to take 10 sweeps at five to ten sites along crop margins especially in crops adjacent to hibernation sites. Record the number of adults collected per 10 sweeps.

Economic Threshold

In Australia, the action threshold is one or more adults per 10 sweeps. US research found 1 adult per 25 sweeps may result in 10% infested peas at harvest.

Management Options

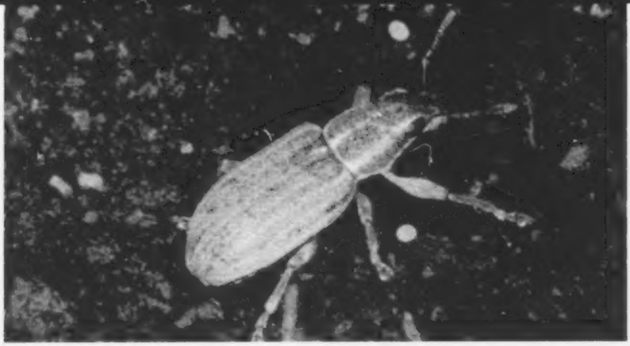
BIOLOGICAL Several natural enemies reported in Russia. Reared parasitoid *Uscana senex* (Grese) parasitized between 50 to 80% of eggs in Chile. Introduction of natural enemies to North America has been unsuccessful to date.

CULTURAL Eliminate potential infestation sources such as volunteer peas, pea hay containing weevil-infested peas, and weevil-infested peas in storage. Plant weevil-free seed or seed that has been fumigated. Harvest peas early before adults emerge to prevent them from moving to hibernation sites.

PHYSICAL Lower the temperature in stored peas to 5°C minimum to reduce survival of overwintering adults.

CHEMICAL Apply insecticide treatments before adults lay eggs on the pods.

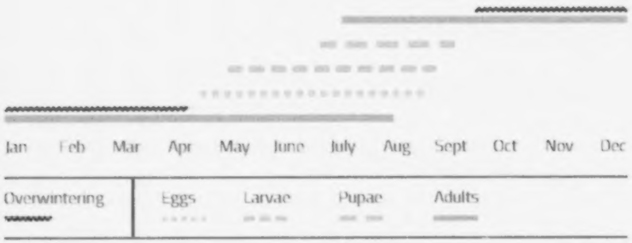
Note: this is only a potential pest and has not yet been found in Western Canada.

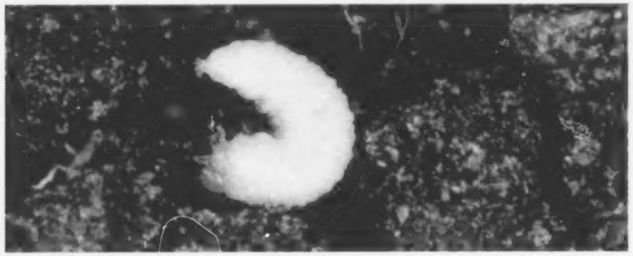


Pea leaf weevil – adult, eggs
Mike Dolinski, MikeDolinski@hotmail.com

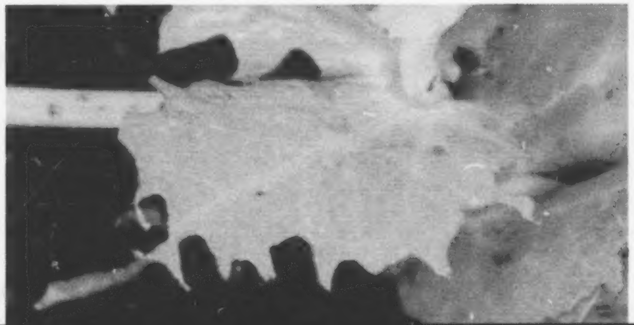
Weevil, pea leaf

Sitona lineatus (Linnaeus)





Pea leaf weevil – larva
Mike Dolinski, MikeDolinski@hotmail.com



Pea leaf weevil – damage
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

LARVAL HOSTS: Field peas, faba beans.

ADULT HOSTS: Other cultivated and wild legumes (e.g. alfalfa, beans, clover, lentils, lupins, and vetch).

Identification

ADULTS: Slender, greyish-brown, about 5 mm long with a short snout. Characteristic three light-coloured stripes extending length-wise down the thorax onto the elytra.

MATURE LARVAE: 3.5-5.5 mm long, c-shaped, legless with brown head.

Life Cycle

Overwinters as adults in soil within or adjacent to alfalfa and other perennial legume crops. In the spring adults disperse by flying (> 17 °C) or walking short distances. Each female lays up to 300 eggs throughout the summer in the soil near or on developing plants. Newly hatched larvae move to the nodules where they feed. Larvae undergo 5 instars and feed on Rhizobium nodules then pupate in the soil. Newly emerged adults search for any pulse crops to continue feeding before overwintering.

Feeding Damage

ADULTS: Feed on leaf margins (notching) and growing points of host seedlings, but damage is non-economic. Not a problem after 5th node stage.

LARVAE: Feed on the nitrogen-fixing nodules causing partial or complete inhibition of nitrogen fixation by the plant, resulting in poor plant growth and low seed yields.

Similar Species

Sweetclover weevil (Sitona cylindricollis (Fåhraeus) (p. 32)) is similar in size and colour but lacks the 3 lines on the thorax and abdomen. The clover root curculio (*Sitona hispidulus* (Fabricius)) is about the same size and also has 3 pale stripes down the thorax but they do not extend onto the elytra.

Monitoring/Scouting

Up to the 5th node stage, examine the clam leaf of 10 plants for the notches at each of five sites along the field edge and another five sites within the field when the pea crop is at the second or third node stage. If notches occur on the lower leaves but not on the clam leaf, then the weevil has likely already laid its eggs and it's too late to spray.

Economic Threshold

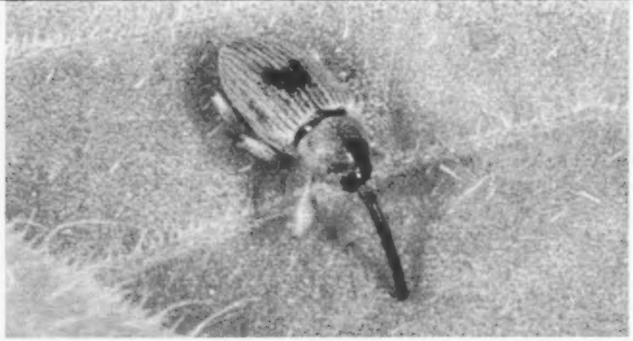
30% of seedlings with damage (leaf notching) on the clam leaf during the 2nd to 5th node stage. The crop is not susceptible to damage after the 6th node stage or it is too late to attempt control.

Management Options

BIOLOGICAL: Ground beetles, rove beetles and other natural enemies feed on eggs.

CULTURAL: Trap crops of winter peas around field margins to attract dispersing adults which can be sprayed if necessary. Seed crop as early as possible and inoculate and fertilize as more mature, vigorous plants better withstand weevil attack. Crops grown in soils with sufficient nitrogen are not at risk of damage.

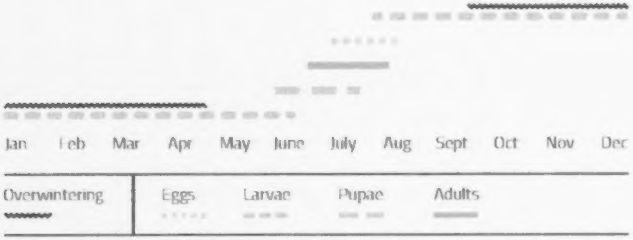
CHEMICAL: Use seed treatments where pea leaf weevils are a constant threat. Otherwise, apply recommended foliar sprays against the adults as required. Keep monitoring as weevils may re-invade fields.

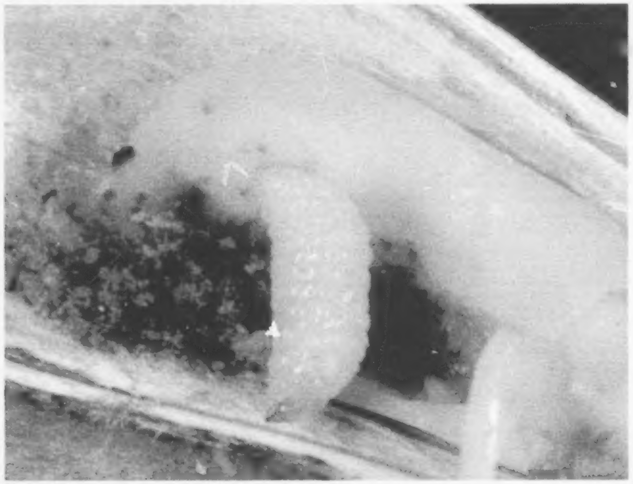


Red sunflower seed weevil – adult
Frank Peairs, Colorado State University, Bugwood.org

Weevil, red sunflower seed

Smicronyx fulvus LeConte





Red sunflower seed weevil – larva, damage
Frank Peairs, Colorado State University, Bugwood.org

Hosts

Sunflower

Identification

ADULTS: 2.5–3 mm long, covered with reddish-orange, oval scales; long narrow snout.

MATURE LARVAE: Small, cream coloured, legless, and C-shaped.

Life Cycle

Overwinters as larvae in the soil. Females lay a single egg/seed when heads reach 40% bloom (the outer 40% of the florets have opened). Mature larvae leave the seed and drop to the ground to pupate in the soil. One generation per year.

Feeding Damage

ADULTS: Feed on bracts (pin holes) and pollen prior to seed development; non-economic injury.

LARVAE: Larval feeding reduces seed weight and oil content. Partially damaged seeds cause downgrading of confectionary sunflower seed.

Similar Species

Nymphs of minute pirate bugs (p. 128); gray sunflower seed weevil (*Smicronyx sordidu* LeConte). Adults are larger (3–3.5 mm) and larvae cause seeds to enlarge unlike the red sunflower seed weevil.

Monitoring/Scouting

When yellow ray flowers begin to appear, examine 5 heads at 10 sites following a "Z" or "X" pattern beginning at least 30 m from a field margin. Counts should continue until the economic threshold level is reached or most plants have reached 70% pollen shed at which time very few seeds are suitable for egg laying. To improve accuracy of assessment, brush the heads vigorously, or spray them with a DEET product to force the adult weevils to the surface of the heads.

Economic Thresholds

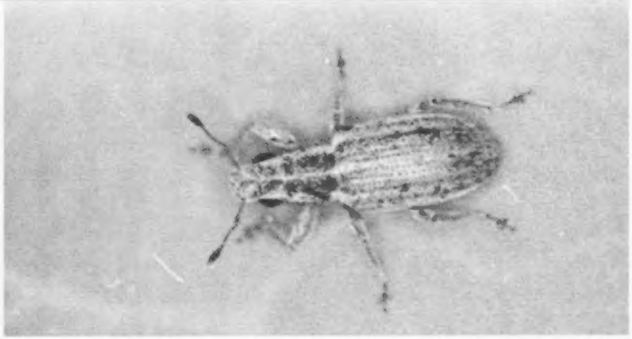
Sunflowers grown for oil, 12–14 weevils/head; sunflowers grown for confection, 1–2 weevils/head.

Management Options

BIOLOGICAL: Several species of parasitic wasps and flies and a fungus found in the soil.

CULTURAL: Seed a trap crop of an earlier flowering variety around field margins to attract egg-laying females which can be controlled before entering the main crop. Earlier seeding can lead to problems with banded sunflower moth. Fall or spring moldboard tillage has reduced the overwintering larval populations and adult weevil emergence the following spring.

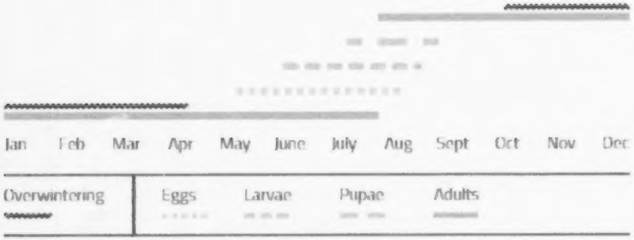
CHEMICAL: If required, insecticides should only be applied before three out of ten plants reach 40% bloom (not all plants reach 40% bloom). Spray when bees and other pollinators are less active (late evening or early morning).

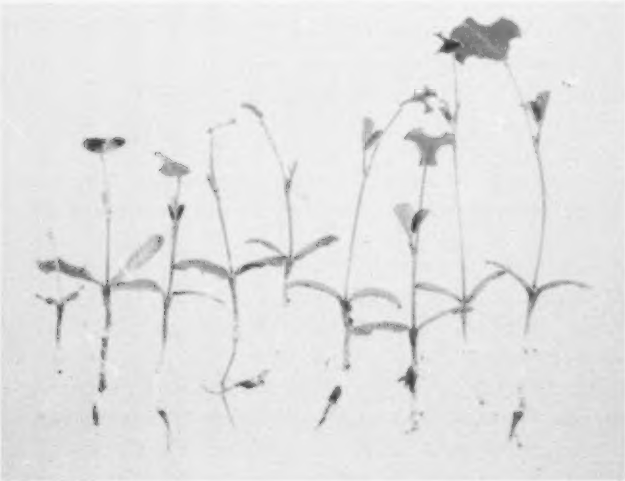


Sweetclover weevil – adult
Mike Dolinski, MikeDolinski@hotmail.com

Weevil, sweetclover

Sitona cylindricollis (Fåhraeus)





Sweetclover weevil – damage
AAFC

Hosts

Sweet clover; alfalfa and cicer milkvetch in absence of sweet clover.

Identification

ADULTS: 4-5 mm dark gray to brown beetles with a short snout. Will drop from plants and play dead when disturbed.

MATURE LARVAE: 5-6 mm whitish, grub-like.

Life Cycle

Overwinters as adults in crop debris or soil cracks in sweet clover fields. Females lay up to 1600 eggs in the soil near the base of host plants where larvae develop in the top 15 cm of soil . Mature larvae move to within 5–8 cm of the soil surface to pupate. One generation per year.

Feeding Damage

ADULTS: Feeding damage to leaves—crescent-shaped and jagged notches—is characteristic of this pest. It may also feed on stems and developing seeds in pods. Damage is most severe in dry years. Seedling crops can be severely thinned or killed. Second-year stands can be thinned or stunted. Weevil cannot complete development on alfalfa.

LARVAE: Feed on roots; however, feeding does not affect plant development or vigor.

Similar Species

The pealeaf weevil (*Sitona lineatus* Linnaeus (p.30)) resembles the sweetclover weevil in its size and coloration, but differs by having 3 stripes on its thorax and elytra.

Monitoring/Scouting

Inspect seedling crops for signs of adult feeding.

Economic Threshold

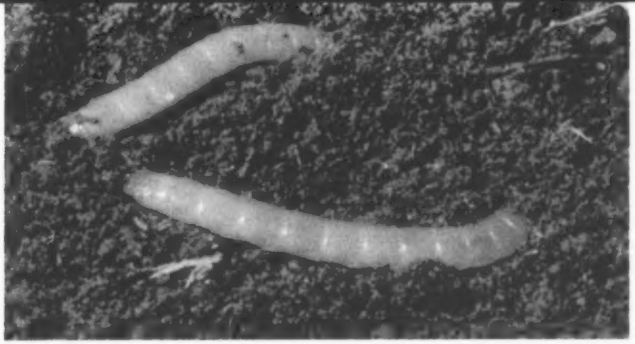
First-year stand: 1 adult weevil/3 seedlings (1/5 seedlings under dry conditions). Second-year stand: 9-12 adult weevils/plant.

Management Options

BIOLOGICAL: Specific natural enemies are not known that can regulate pest populations.

CULTURAL: Vigorously growing second-year plants can outgrow adult feeding. Plant successive sweet clover crops widely apart in rotation with other crops. Sow seed in a firm moist seedbed at recommended depth to encourage rapid and uniform emergence and early development to better withstand weevil attack. Cultivate infested crops right after harvest to kill larvae on roots by predation, exposure, and crushing.

CHEMICAL: Apply a control product if crop shows noticeable thinning or stunting.



Wireworms – larva
Mike Dolinski, MikeDolinski@hotmail.com

Wireworms

prairie grain wireworm
Ctenicera destructor (Brown)

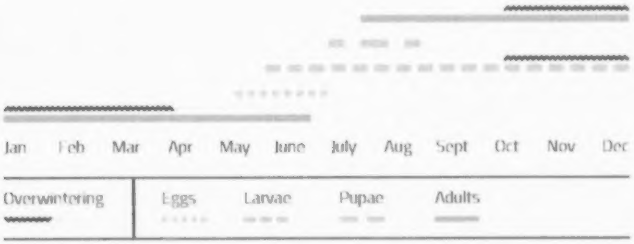
Hypnoidus bicolor (Eschscholtz)

lined click beetle
Agriotes lineatus (Linnaeus)

western wireworm
Agriotes sparsus LeConte

wheat wireworm
Agriotes mancus (Say)

dusky wireworm
Agriotes obscurus (Linnaeus)



Prairie grain wireworm (*Ctenicera destructor* (Brown)) and *Hypnoidus bicolor* (Eschscholtz) are the two most common wireworm species found in field crops on the Prairies. Other species that can be abundant in some areas of Western Canada include the lined click beetle (*Agriotes lineatus* (Linnaeus)), western wireworm (*Agriotes sparsus* LeConte), wheat wireworm (*Agriotes mancus* (Say)) and the dusky (*Agriotes obscurus* (Linnaeus)).

Hosts

All field crops.

Identification

ADULTS: 8-12 mm long depending on species; adults will characteristically make an audible clicking sound when they try to right themselves when placed on their backs (hence common name-click beetles). They will also play dead when captured.

MATURE LARVAE: Elongated, cylindrical, wiry body, 10-20 mm long; last abdominal segment is flattened with a keyhole-shaped notch.

Life Cycle

Only one generation per year, however the larval stage can last 4 to 11 years depending on species. Both new adults and larvae overwinter. Larvae pupate in earthen cells, and the new adults remain in the cell until the following spring.

Feeding Damage

ADULTS: Feed on pollen of flowering weeds and ornamentals.

LARVAE: Feed on germinating seeds and on the underground parts of stems of young seedlings, causing reduced crop emergence and thinned stands. Damage is often blamed on poor quality or dry soil, and occurs only in the spring.

Similar Species

Beetles can be confused with a number of different dark beetles such as the ground beetle (p. 115). However click beetles take flight when disturbed, unlike ground beetles. Larvae can be confused with those of the false wireworm but the latter does not have the keyhole-shaped notch in the last abdominal segment.

Monitoring/Scouting

Detect larvae by burying potato seed pieces, pre-soaked corn-wheat mixture or oatmeal 5–10 cm in the soil at 10 or so locations through a field 2–3 weeks before planting. Be sure to mark the locations. Examine the baits after 2 weeks for larvae. Competition from an abundant food supply in the soil around where the baits are buried can greatly reduce the number of wireworms recovered. Soil may also be sieved through a screen to look for wireworms.

Economic Threshold

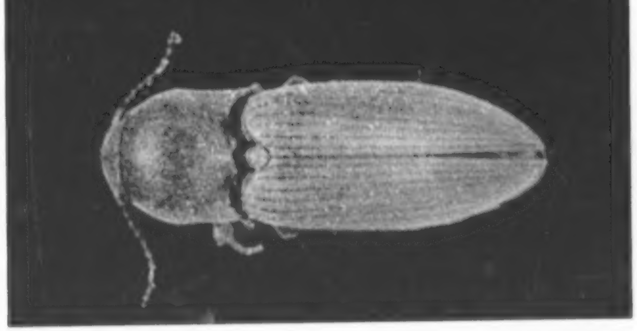
None established.

Management Options

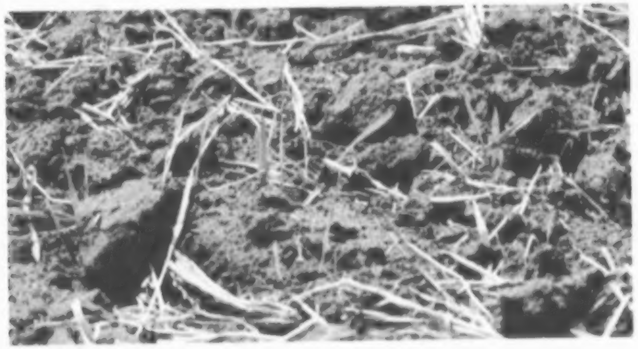
BIOLOGICAL: Predators of wireworms include ground beetles (p. 115), rove beetles (p. 117), and larvae of stiletto flies (Therevidae) (p. 121). The fungus *Metarhizium anisopliae* can infect and kill wireworms.

CULTURAL: Keep summer fallow fields free of green growth in June-July to starve newly hatched larvae. Use seeding practices that encourage rapid germination and vigorous seedling growth. Rotation with non-host crops may help reduce egg-laying and larval development.

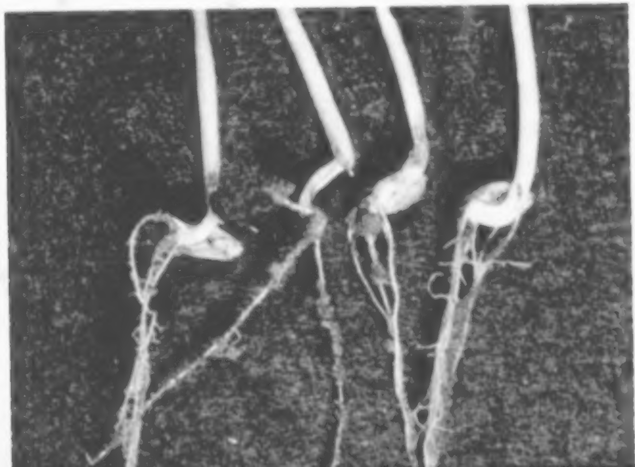
CHEMICAL: Foliar sprays are not effective. Seed treatments can help reduce damage.



Wireworms
(continued)

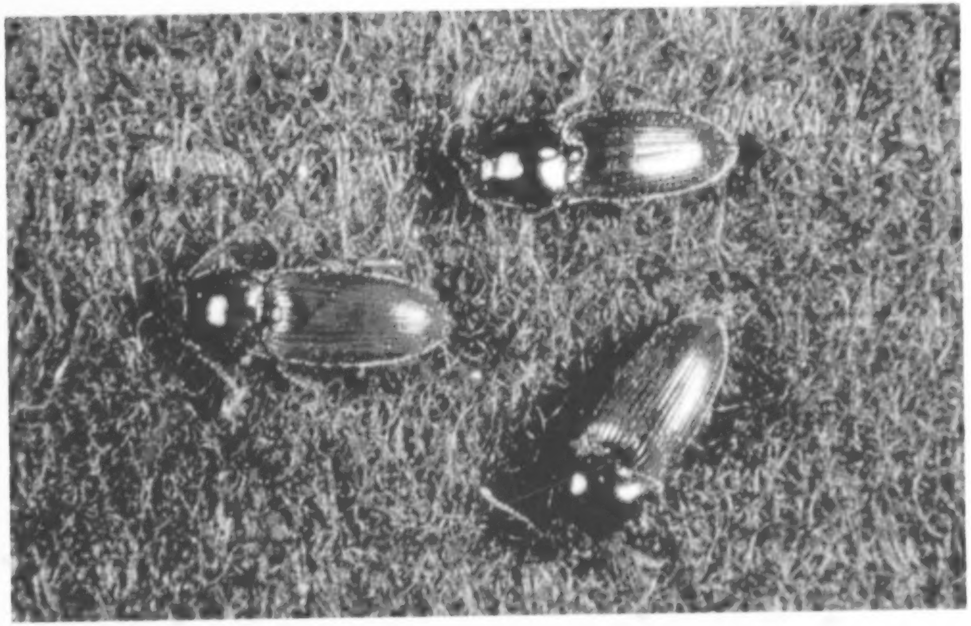


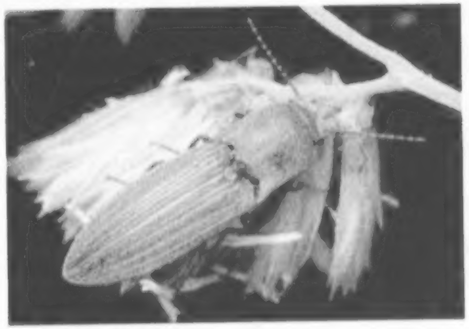
Wireworm – damage
Mike Dolinski, MikeDolinski@hotmail.com



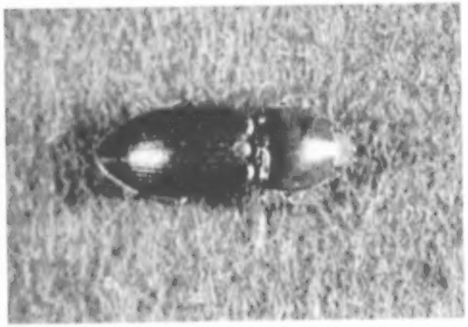
Dusky wireworm – adult
Eric LaGasa, Washington State Department of Agriculture, Bugwood.org

Hypnoidus bicolor – adult
AAFC



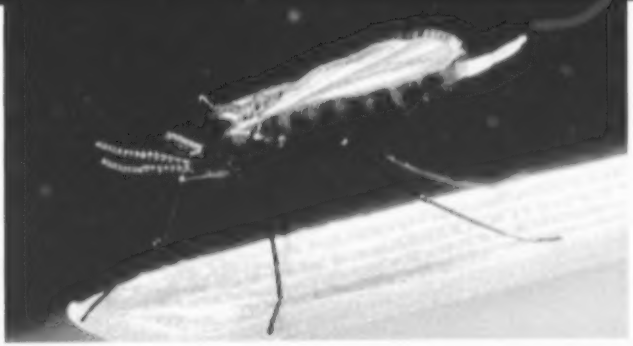


Lined clickbeetle – adult
Boris Loboda



Prairie grain wireworm – adult
AAFC

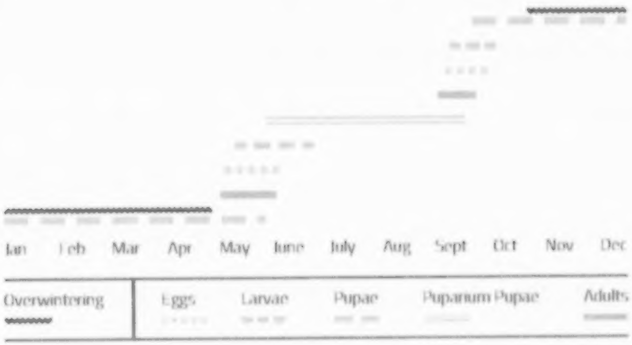
Prairie grain wireworm – damage
AAFC

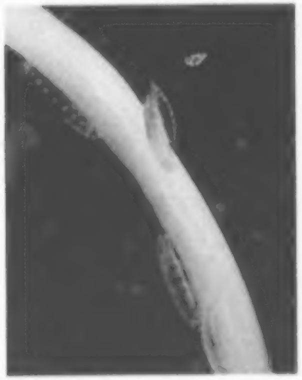


Hessian fly – adult
Scott Bauer, USDA Agricultural Research Service, Bugwood.org

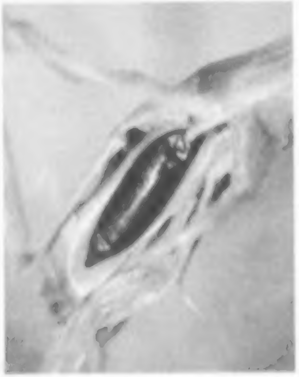
Fly, Hessian

Mayetiola destructor (Say)





Hessian fly – larva
Peggy Greb, USDA Agricultural Research Service, Bugwood.org



Hessian fly – pupa
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

ADULT HOSTS Nectar and plant sap, aphid honeydew.

LARVAL HOSTS Wheat, quackgrass, timothy, rye grasses, and western wheatgrass.

Identification

ADULTS 4 mm long, delicate dark-bodied flies with slender long black legs and slender beaded antennae.

MATURE LARVAE 4-5 mm long, with translucent greenish stripe down back of reddish-orange body.

Life Cycle

Overwinters as larvae in "flaxseed" puparium at base of host plants. Females lay 250–300 reddish eggs over their short (2-3 days) life span in short rows on the underside of leaves of young host plants or tillers. Survives July-August as larvae within the puparium before resuming development to produce the second generation.

Feeding Damage

ADULTS None.

LARVAE Feed on crown tissue causing stems to deform, fall or lodge (early summer), or plants die or are severely stunted (fall). Late spring infestations will cause stem breakage at the lowest node above the ground. Injured plants will yield less. Leaves of infested plants are dark bluish-green and stand more erect than those of uninfested plants.

Similar Species

Wheat midge (p. 43) may be present during heading. It has an orange body. Adults of other species of midges that feed on decaying plant matter and fungi may also be present.

Monitoring/Scouting

In areas of poor stand and stunted plants in the field, collect 50 young spring and winter wheat stems and pull back leaves at the base of the stems to expose any "flaxseed" puparia.

Economic Threshold

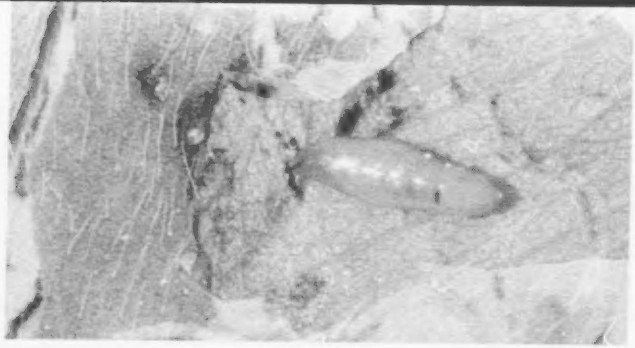
None. Heavily infested crops can suffer economic damage; however its presence in host grasses in forage crops may require prescribed phytosanitary measures (bale compression or fumigation) for export to some foreign markets.

Management Options

BIOLOGICAL The endoparasitoid *Platygaster hiemalis* Forbes (p. 136) lays its eggs in Hessian fly eggs and newly hatched larvae in the fall. Another parasitoid that attacks the Hessian fly is the *Pediobius eubius* (Walker) (p. 134).

CULTURAL Seed resistant varieties of wheat; or seed winter wheat after mid-September to reduce exposure of seedlings to flies. Early seeded spring wheat is less susceptible to stem breakage caused by Hessian fly than later seeded wheat. If practical, disc in stubble right after harvesting to bury larvae/pupae. Eliminate volunteer hosts available for egg laying. Do not seed wheat on wheat.

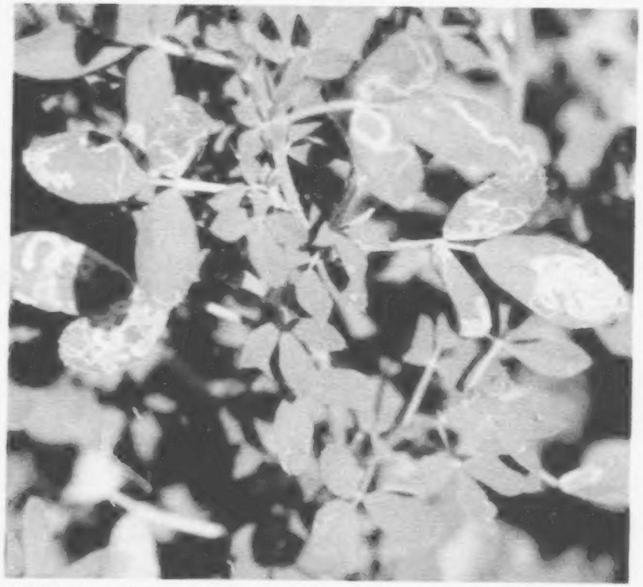
CHEMICAL None registered in Canada.



Alfalfa blotch leafminer – larva
Whitney Cranshaw, Colorado State University, Bugwood.org

Leafminer, alfalfa blotch

Agromyza frontella (Rondani)



Alfalfa blotch leafminer – damage
Whitney Cranshaw, Colorado State University, Bugwood.org

Hosts

Alfalfa.

Identification

ADULTS 3 mm long, black hump-backed fly.

MATURE LARVAE 3-4 mm long, yellow maggots.

Life Cycle

Overwinters as pupae in the soil. Each generation takes 30–40 days, so up to 4 generations per year depending on weather conditions. Females lay a total of about 140 eggs, 1–3 eggs per leaf over their short life span. Larvae are cannibalistic. Mature larvae drop to the ground and pupate in the soil.

Feeding Damage

ADULTS Small pinhole punctures created in leaves by feeding and egg laying.

LARVAE Feed between the top and bottom layers of the leaf, usually beginning at the base of the leaflet and widening towards the leaf apex, creating a "blotch" appearance. Severe feeding injury can cause premature leaf drop but no significant yield loss; some loss in protein content under moderate–severe feeding injury.

Similar Species

Larval feeding damage can be confused with that of a common native serpentine leafminer (*Liriomyza trifoliearum* Spencer) which does not create the larger blotch mines nor is of economic importance.

Monitoring/Scouting

Once leaves appear in the spring and after each cutting, examine 5 plants at 10 randomly selected sites and record the number of leaflets with pinholes.

Economic Threshold

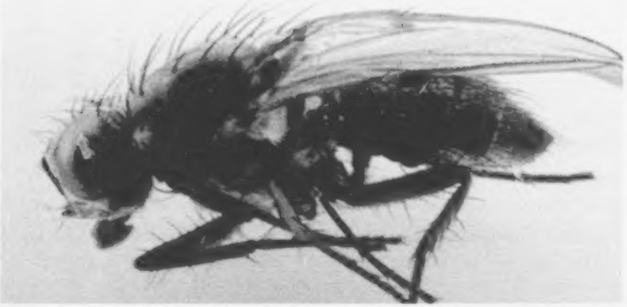
HAY CROPS 40% of leaflets show adult feeding damage (pinholes).

Management Options

BIOLOGICAL A native parasitic braconid wasp (*Dacnusa dryas* (Nixon) (p. 130)) can reduce populations by up to 98% in the absence of harmful sprays.

CULTURAL Earlier cutting to reduce feeding damage; remove hay as soon as possible to reduce larval pupation.

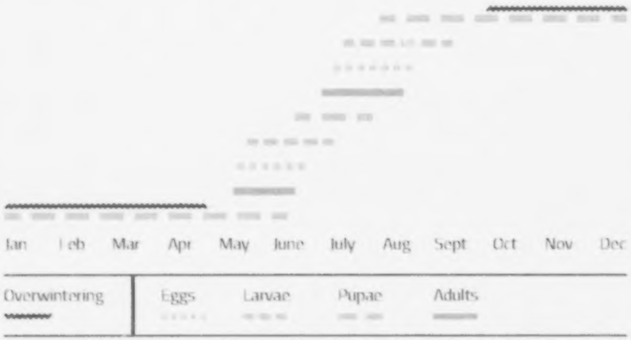
CHEMICAL Insecticides reduce larval feeding but not adult feeding damage. Once the threshold is reached, spray crop before noticeable leaf mining appears.

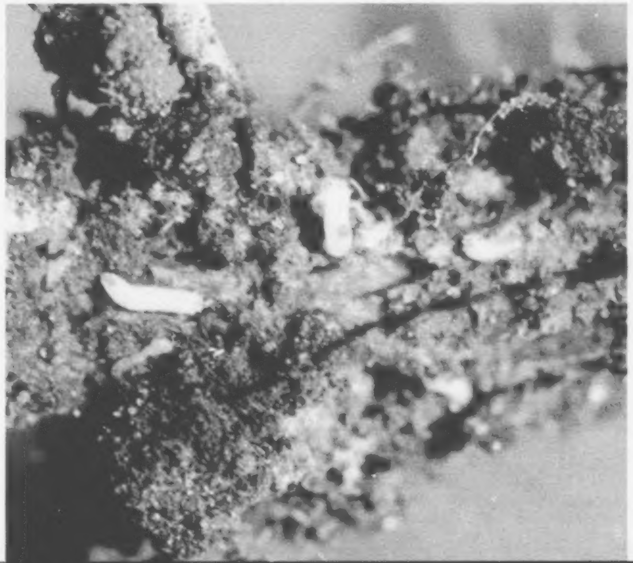


Cabbage maggot – adult
Tyler Wist, AAFC

Maggot, cabbage/turnip

Delia radicum (Linnaeus)/ *Delia floralis* (Fallen)





Cabbage maggot – larva, damage
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

Canola, mustard, cabbage, rutabaga, radishes, cauliflower, and broccoli. Cabbage maggot is the most common species attacking canola.

Identification

ADULTS 4-6 mm long, light gray flies; wings overlap when at rest.

MATURE LARVAE 8 mm long, whitish maggots.

Life Cycle

Overwinters as pupae in the soil of host crops. Each female lays up 200 elongate white eggs at the base of host plants. Usually one generation, but two overlapping generations are possible during warmer or extended summers.

Feeding Damage

ADULTS None; feed on the nectar of various flowers.

LARVAE Infestations and damage are more severe under cool, damp soil conditions. Larvae feed on the roots of seedlings and developing host plants; mature larvae create channels on or tunnel into tap roots causing lower leaves to turn yellow. Damage may also promote disease that further affects plant growth. Heavy infestations can delay blooming and cause severe lodging and yield losses. Infested canola roots are often darker than normal roots. Damage is more severe under cool temperatures and wet soil conditions.

Similar Species

Seedcorn maggot (*Delia platura* (Meigen) (p. 38)).

Monitoring/Scouting

Scout for the presence of all adult root maggots starting in mid to late May using yellow sticky cards or sweep nets.

Economic Threshold

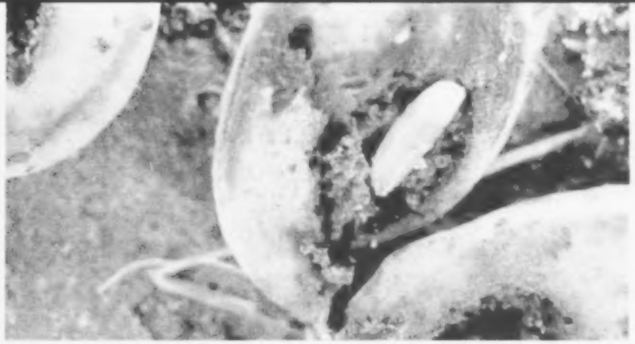
None established.

Management Options

BIOLOGICAL Several species of predators and parasitoids attack all root maggot life stages and provide the greatest protection against root maggot depredation in canola. Ground beetles (p. 115) and rove beetles (e.g. *Aleochara bilineata* Gyllenhaal (p. 117)) feed on eggs, larvae, and puparia; nematodes attack the larvae. Some fungal and bacterial pathogens also provide some control.

CULTURAL Rotate host crop with non-host crop. Avoid planting *Brassica rapa* (Polish canola) cultivars which are more susceptible to damage than *B. napus* (Argentine canola) cultivars and brown and yellow mustards. Increased seeding rate and row spacing can decrease root maggot damage. Spring and/or fall tillage may reduce fly emergence by exposing puparia to predation. In some instances severely damaged crops could be ploughed under and immediately reseeded.

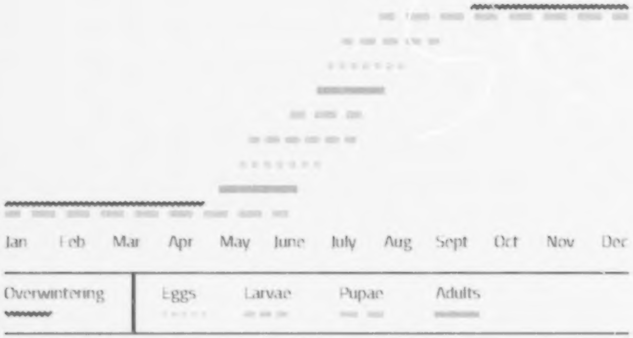
CHEMICAL None registered in Canada.



Seedcorn maggot – damage (beans)
John Gavloski, Manitoba Agriculture, Food and Rural Development

Maggot, seedcorn

Delia platura (Meigen)



Seedcorn maggot – damage
Clemson University, Bugwood.org

Hosts

Canola, turnips, cabbage, onions and leeks, beans (snap, kidney, lima), corn, soybeans, peas, lettuce, carrot, and cucurbits.

Identification

ADULTS: 6 mm long, gray flies; wings overlap when at rest.

MATURE LARVAE: 8 mm long, whitish maggots.

Life Cycle

Overwinters as reddish brown pupae in the soil of harvested host crops. Usually one generation but two overlapping generations are possible during warmer or extended summers. Females lay their average of 250–300 eggs in batches of 25–30 in freshly-tilled soils high in moisture and organic matter. Will also lay eggs on hosts infested with other root maggots.

Feeding Damage

ADULTS: None.

LARVAE: Feed on germinating seeds of host plants and as secondary feeders on damaged tap roots of host plants. Damage is more severe under cool temperatures and wet soil conditions.

Similar Species

Cabbage maggot (*Delia radicum* (Linnaeus)) and turnip maggot (*Delia floralis* (Fallen) (p. 37)).

Monitoring/Scouting

Scout for the presence of all adult root maggots starting in mid to late May using yellow sticky cards or sweep nets.

Economic Threshold

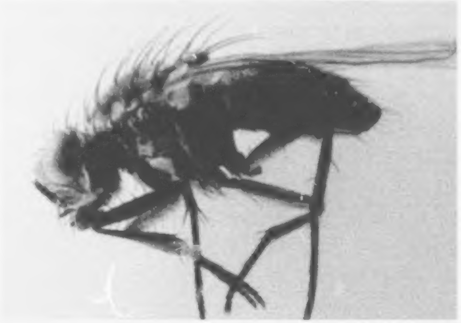
None established.

Management Options

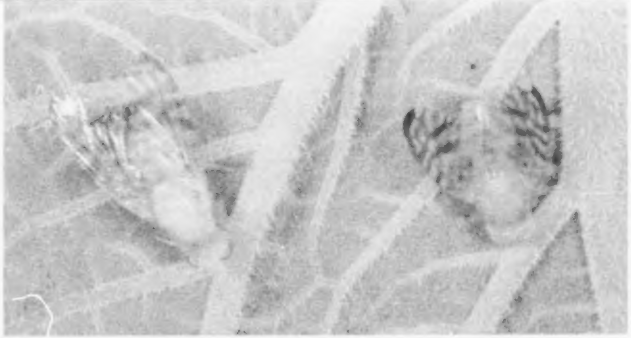
BIOLOGICAL: Several species of predators and parasitoids attack all root maggot life stages and provide the greatest protection against root maggot depredation. Ground beetles (p. 115) and rove beetles (e.g. *Aleochara bilineata* Gyllenhaal) (p. 117)) feed on eggs, larvae and puparia; nematodes attack the larvae. Some fungal and bacterial pathogens also provide some control.

CULTURAL: Rotate host crop with non-host crop. Increasing the seeding rate can decrease root maggot damage. Spring and/or fall tillage may reduce fly emergence by exposing puparia to predation. Depending on the crop, severely damaged crops could be ploughed under and immediately reseeded.

CHEMICAL: Seed treatments are registered for beans, peas, soybeans, and corn.



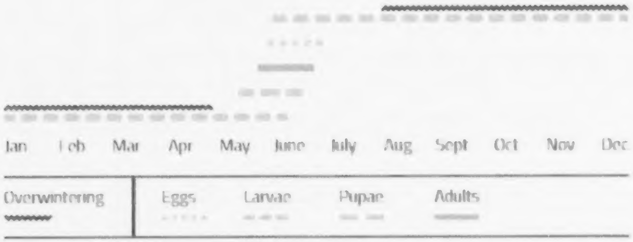
Seedcorn maggot – adult
Tyler Wist, AAFC

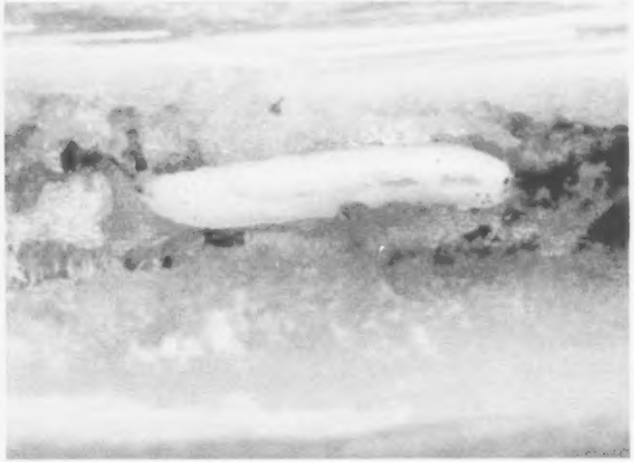


Sunflower maggot – adult
Frank Peairs, Colorado State University, Bugwood.org

Maggot, sunflower

Strauzia longipennis (Wiedemann)





Sunflower maggot – larva, damage
John Gavloski, Manitoba Agriculture,
Food and Rural Development

Hosts

Sunflower.

Identification

ADULTS: 6 mm long, yellowish body and 13 mm wingspan; wings bear broad dark bands that form a fairly distinct F-shaped mark near the tips.

MATURE LARVAE: 7 mm long, whitish maggot.

Life Cycle

Overwinter as larvae in plant debris in the soil. Eggs are laid in the pith of young plants. One generation per year.

Feeding Damage

ADULTS: Feed on nectar of flowering plants.

LARVAE: Larvae feed in the pith of the sunflower stalk; however there is no impact on seed yields or marketability. High larval numbers of 8–10 per stalk can cause up to 30% stalk breakage.

Similar Species

The larvae of sunflower receptacle maggot (*Gymnocarena diffusa* (Snow)) and the sunflower seed maggot (*Neotephritis finalis* (Loew)) may be found in the flower heads.

Monitoring/Scouting

None developed.

Economic Threshold

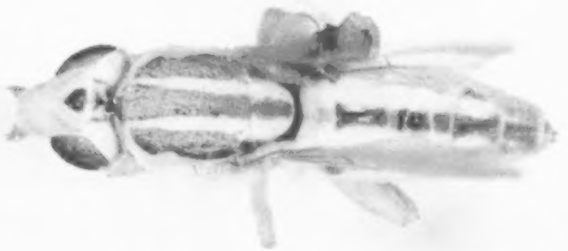
None established.

Management Options

BIOLOGICAL: Pathogenic fungi, predacious ants, spiders, and birds.

CULTURAL: Do not plant successive crops of sunflowers.

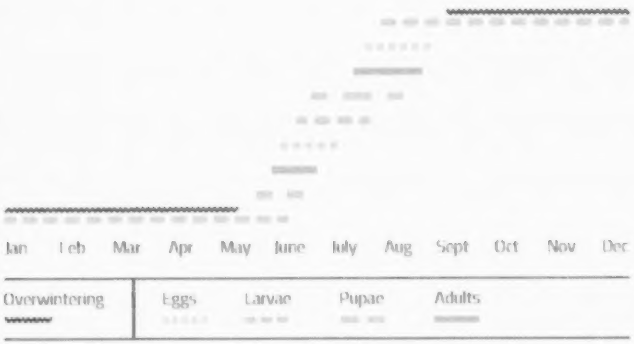
CHEMICAL: None registered in Canada.

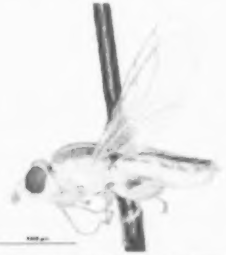


Wheat stem maggot adult – dorsal (top) view
Tyler Wist, AAFC

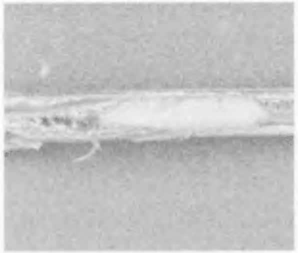
Maggot, wheat stem

Meromyza americana Fitch





Wheat stem maggot adult – side view
Tyler Wist, AAFC



Wheat stem maggot – larva
Mark Boetel, North Dakota State University

Hosts

ADULTS Wheat, rye, barley, oats, millet, timothy, bromegrass, crested wheatgrass, and bluegrass.

Identification

ADULTS 5 mm long, yellowish white delicate fly with distinctive green eyes and 3 black stripes across the thorax and the abdoment.

MATURE LARVAE 7 mm long, green spindle-shaped, tapered at both ends.

Life Cycle

Larvae overwinter inside the lower parts of stems. Eggs are laid on leaves near the stem. Two generations per year.

Feeding Damage

ADULTS None.

LARVAE First generation larvae feed inside of stems just above upper node, killing the upper stem and head (often called white head or silver top). Second generation larvae feed on volunteer hosts in which they will overwinter

Similar Species

The characteristic green eyes and body colouration distinguish this pest from other small flies that may be present in host crops.

Monitoring/Scouting

None; usually only 1-5% of crop is affected.

Economic Threshold

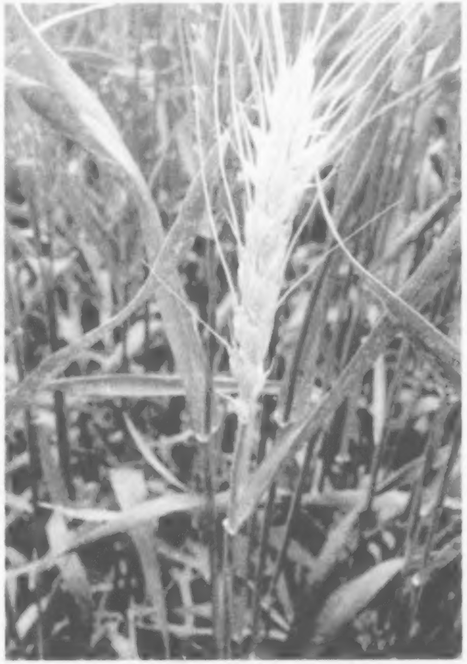
None established.

Management Options

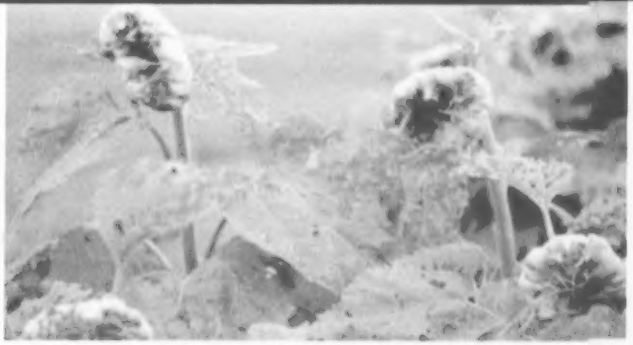
BIOLOGICAL Spiders and some generalist insect predators.

CULTURAL Crop rotation and destruction of infested stubble and volunteer hosts will reduce populations. Delayed planting is an effective management practice where possible. There are no resistant varieties for this pest.

CHEMICAL None registered in Canada.



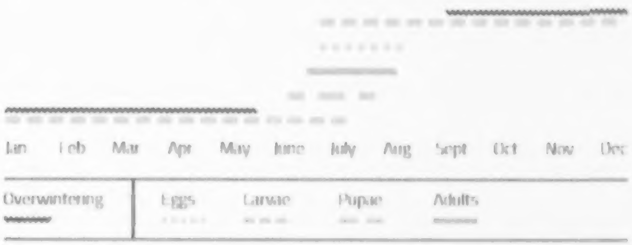
Wheat stem maggot – damage
Emmanuel Byamukama, South Dakota State University



Sunflower midge – damage
John Gavloski, Manitoba Agriculture,
Food and Rural Development

Midge, sunflower

Contarinia schulzi Gagne



Hosts

ADULTS Flower nectar and pollen.

LARVAE Sunflowers.

Identification

ADULTS 2 mm tan-coloured delicate fly with one pair of unmarked transparent wings (4 mm wingspan).

MATURE LARVAE 3 mm long, cream to yellowish white maggots.

Life Cycle

Overwinter as larvae in the soil but some may pupate if conditions are favourable. Adults live only for 2–3 days. Females lay batches of 25–50 visible white eggs on sunflower buds (prefer 25–50 mm diameter size). Mature larvae drop from the heads to pupate in the soil. Only one generation per year.

Feeding Damage

ADULTS None.

LARVAE Feed on the tissue at the base of developing seeds or bracts resulting in decreased seed weights and yields and deformed heads, sometimes with a hole or depression in the centre. Damage is usually restricted to field margins, but may be present throughout the field in severe infestations.

Monitoring/Scouting

Examine heads for signs of larval feeing damage (scarred bracts, twisted or gnarled flowers) and for the presence of larvae at the base of the bracts or feeding in the flower, at the base of the florets.

Economic Threshold

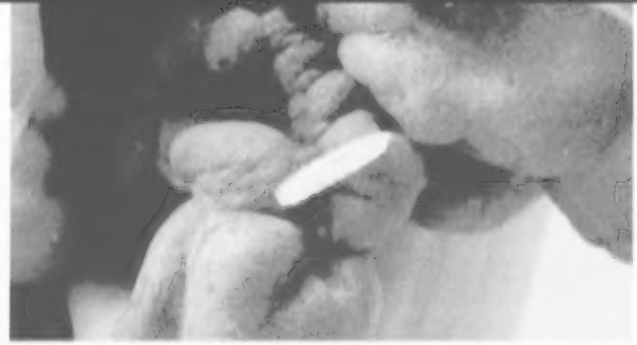
None established.

Management Options

BIOLOGICAL Spiders and some generalist predaceous insects.

CULTURAL If high populations of sunflower midge are anticipated, new fields should be established away from fields damaged the previous season. To minimize risk of all plantings begin at the most susceptible stage when adult midges emerge, several planting dates can be used if practical.

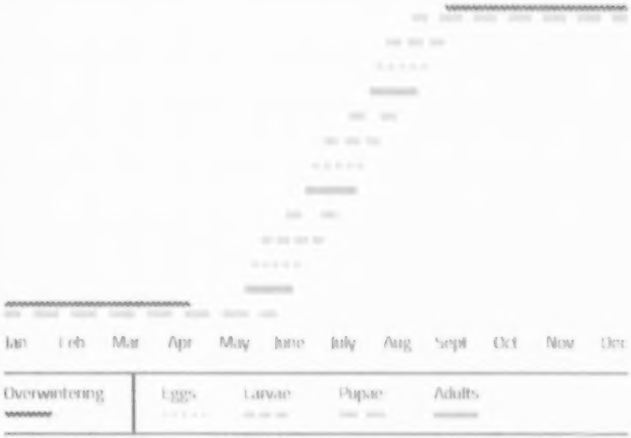
CHEMICAL Not effective in preventing damage.



Swede midge – larva
Jonathan Williams, AAFC

Midge, Swede

Contarinia nasturtii (Keiffer)



Hosts

Canola, mustard, cabbage, cauliflower, Brussels sprouts, and Brassica weeds.

Identification

ADULTS 1.5–2 mm long, delicate, light brown to gray flies with long legs and long beaded antennae; wings have sparse venation.

MATURE LARVAE 3–4 mm long; young larvae are semi-transparent, gradually turn yellow when mature.

Life Cycle

Overwinter as pupae in the soil under host crops. Eggs are laid in clusters of 2–50 on growing points of host plants. Both larvae and pupae require moist environments to mature. Adults live for only few days; pupal stage can last from 14 days to more than a year in the soil until conditions are suitable to complete development to adult stage. There are likely up to 3 overlapping generations per year depending on seasonal soil moisture and temperatures.

Feeding Damage

ADULTS None. Feed on the nectar of flowering plants.

LARVAE Pre-bolting canola, larvae attack the florets at the ends of racemes, causing the growing points to turn brown and dry up. Larval feeding on the growing point can stop stem elongation and leave pods in a cluster ("palm tree" effect). Feeding after first flowering has little impact on yield; however, secondary branches may be stunted if adults arrived later and laid eggs in secondary buds.

Similar Species

Other species of midge-like flies may be present in canola crops feeding on nectar of flowering plants or seeking egg-laying sites in the soil or surface debris.

Monitoring/Scouting

Pheromone-baited traps can be used to detect presence of adults.

Economic Threshold

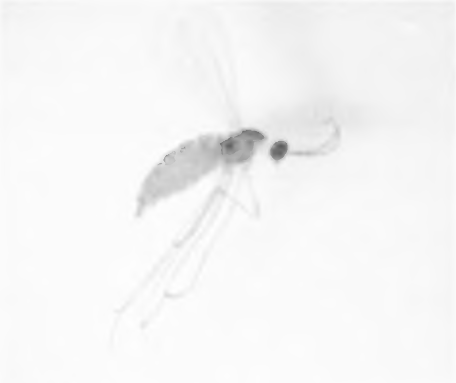
None established. Causes occasional isolated economic crop losses.

Management Options

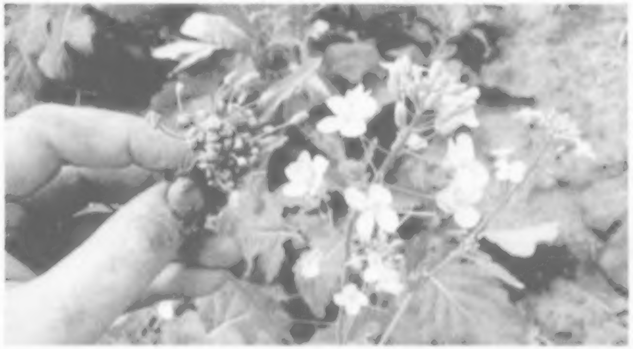
BIOLOGICAL Spiders will feed on adults and exposed larvae on plants; ground beetles and other ground-dwelling predatory insects will attack exposed pupae and larvae.

CULTURAL Tillage or control of volunteer canola in the fall can help reduce overwintering populations. Avoid planting canola within 0.5–1 km of a field infested the previous year.

CHEMICAL Products are available to control adults, eggs, and larvae; if sprays are required, they should be applied before bloom to be most effective in reducing egg laying and larval damage. However, because of the overlapping generations, sporadic distribution within fields, and absence of significant crop losses, spraying is not encouraged.



Swede midge – adult
Susan Ellis, USDA APHIS PPQ, Bugwood.org

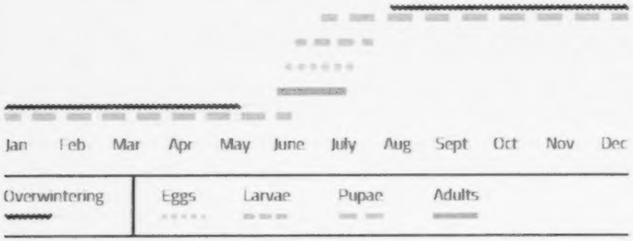


Swede midge – damage
Charles-Étienne Ferland, University of Guelph

Wheat midge – larva
Mike Dolinski, MikeDolinski@hotmail.com

Midge, wheat

Sitodiplosis mosellana (Gehin)



Hosts

Spring and winter wheat, durum wheat, triticale, occasionally spring rye; crops tolerant to attack include six-row barley, annual canarygrass, and oats.

Identification

ADULTS: Small (2-3 mm long) orange body with large black eyes and relatively long legs and antennae.

MATURE LARVAE: 2-3 mm long, maggots; young larvae translucent white, gradually turning bright orange when mature.

Life Cycle

Overwinter as mature larvae in silken cocoons 5–10 cm in the soil where they will survive for several years until suitable soil moisture conditions (> 22 mm rainfall in May or June) stimulate pupation and subsequent adult emergence. If precipitation is less than 22 mm prior to the end of May there may be a later and extended period of midge emergence. Eggs are laid in the evening (wind <10 kph, > 15°C) on the surface of the glumes or in grooves on the florets. Eggs hatch in 4-7 days and larvae feed for 2-3 weeks. Mature larvae may remain in the head under dry conditions and only drop to the ground when it rains. Only one generation per year.

Feeding Damage

ADULTS: None.

LARVAE: Feed on the surface of developing wheat kernels. Depending on the host crop variety (synchrony between egg-laying and heading), number of larvae, and stage of kernel development, feeding damage includes aborted, shriveled, misshapen, cracked, or scarred kernels that lowers grain yield, quality, and grade.

Similar Species

A non-pest species of small midge-like insects such as the Lauxanid, *Camptoprosopella borealis* Shewell, may be found in host crops feeding on nectar of flowering weeds or seeking egg-laying sites in the soil or surface debris. Adults of other species of midge pest (e.g. Hessian fly) or non-pest (fungus/detritus feeders) species may also be present on flowering crops and nearby vegetation.

Monitoring/Scouting

Set out three pheromone-baited traps or ten yellow sticky traps per 64 ha (160 ac) 4-5 days before heading to detect presence of adults. Alternatively, a degree day development model is available to determine first emergence and percent adult emergence to help time field inspections. Fields should be inspected daily (at dusk, wind <10 kph, >15°C) from the time wheat heads emerge from the boot leaf until anthers are visible on the heads. Count the number of wheat midge adults on 4-5 wheat heads at 4-5 sites within the crop. Consider sampling an equal number of sites along the crop margins where infestations can be higher due to migration from nearby infested fields. Consult your provincial agriculture web site or local offices for current midge forecast reports (reports based on pupal counts).

Midge, wheat
(continued)

Economic Threshold

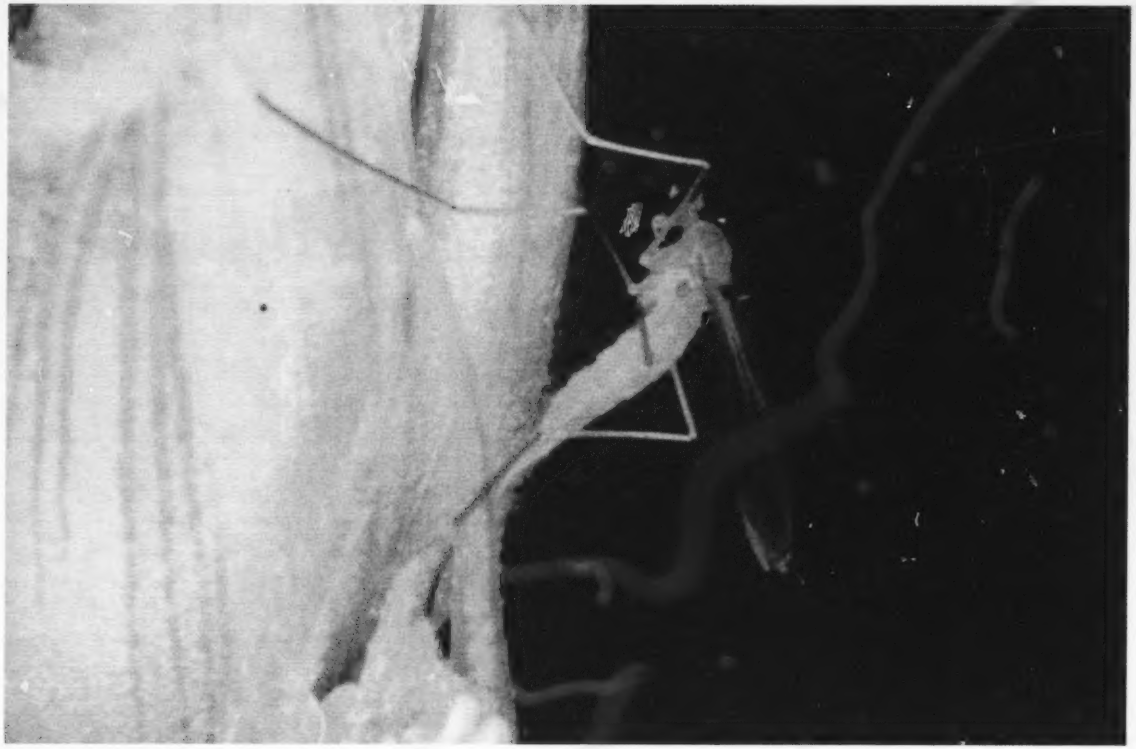
Pupal counts exceeding 600 cocoons/m^2 can cause significant damage and economic losses in unprotected crops the following spring. An average of one or more adults/4–5 heads is the recommended threshold for insecticide treatments when preventing yield loss is the target. An average of one or more adults/8–10 heads is the recommended threshold for insecticide treatments when preventing grade loss (No, 1) is the target. For sticky traps, 10 midge on the ten cards signals the possible need for insecticide treatment (4–10 for high value varieties).

Management Options

BIOLOGICAL On the Prairies, introduced parasitic wasps, *Macroglenes penetrans* (Kirby) (p. 137) and *Platygaster tuberosula* (Kieffer) (p. 136), which can provide sufficient biological control to reduce the frequency of economic infestations if insecticides are used judiciously in the spring/early summer. In southern B.C., another small parasitic wasp, *Euxestonotus error* (Fitch) (p. 136) attacks the wheat midge.

CULTURAL Avoid continuous cropping of wheat in the same fields. Severely infested fields should be cropped with non-susceptible crops. Higher seeding rates and earlier planting can reduce damage. Where cocoon density exceeds 1200/m^2, plant a wheat midge-resistant variety with a susceptible variety (90:10 blend). Information on midge-tolerant varieties and blends is posted at www.midgetolerantwheat.ca/.

CHEMICAL Consult product labels for correct dosage and timing of sprays. Spraying once the crop has flowered is not recommended because the crop is no longer at risk, the sprays are much less effective after flowering, and important parasitoids are exposed to unnecessary, harmful residues.

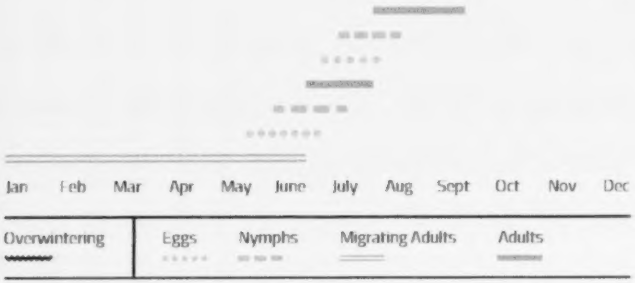


Wheat midge – adult
Mike Dolinski, MikeDolinski@hotmail.com

Aster leafhopper – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development

Leafhopper, aster

Macrosteles quadrilineatus Forbes



Aster leafhopper – damage (aster yellow infection)
Chrystel Olivier, AAFC

Hosts

Canola, alfalfa, flax, carrots, celery, lettuce, wheat, many grasses, and fruiting and ornamental trees and shrubs.

Identification

ADULTS: 5–6 mm long, olive-green or straw coloured, wedge-shaped, with distinctive six dark coloured spots on the forehead; readily fly when disturbed.

MATURE NYMPHS: 5 mm long, yellow or light brown to a pale greenish-gray body with small wing pads. Can be confused with aphid nymphs which walk slower, have cornicles, and have ovate rather than wedge-shaped bodies. Also, leafhopper nymphs tend to walk somewhat sideways.

Life Cycle

Most leafhoppers blow up from the southern U.S. each spring on southerly winds. Adults settle on grasses and forages (e.g. winter wheat, alfalfa) where they mate before moving to summer food hosts to lay eggs. Populations are killed off in the fall although a few adults may survive the winter in protected locations. Two overlapping generations per year, depending on numbers arriving and timing in the spring, and suitable weather for development.

Feeding Damage

ADULTS AND NYMPHS: Feed by piercing and sucking up plant fluids. Normally 3–5% of the leafhoppers carry aster yellows phytoplasma. Aster yellows disease is not fatal to canola but distorts floral parts and pods causing misshapen and malformed seeds, which often shrivel up and blow out of the combine. Infected plants take on a purple tinge and normal pods are replaced by hollow, kidney-shaped, bladder-like seedless structures. No canola varieties are known to be resistant to the disease. In flax, instead of producing flowers, the tops of plants produce additional leaves, which tend to turn yellow.

Similar Species

Potato leafhopper (p. 46). There are many species of leafhoppers in and around crops.

Monitoring/Scouting

None developed.

Economic Threshold

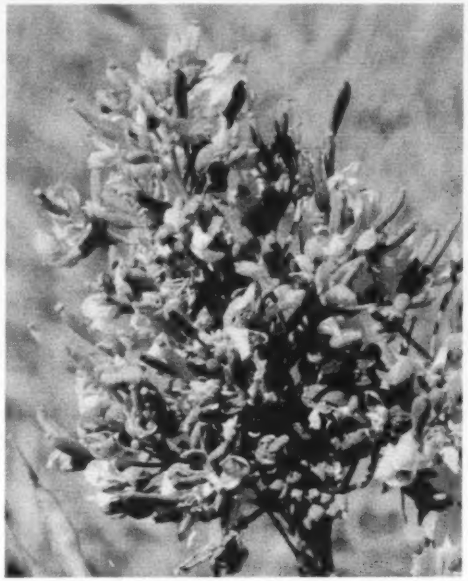
None established.

Management Options

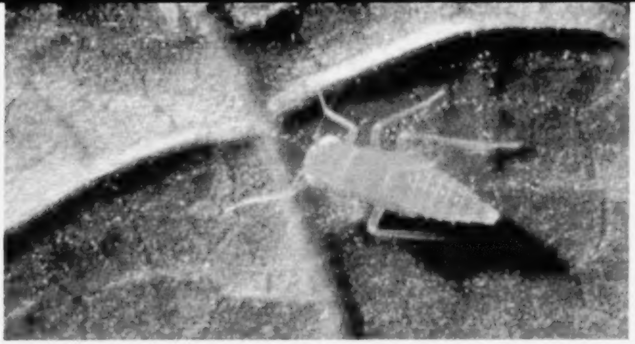
BIOLOGICAL: Spiders (pp. 111-114), green lacewings (p.139) and other generalist predatory insects.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL: Cost of treatment is not justified by value of crop loss due to aster yellows in field crops.



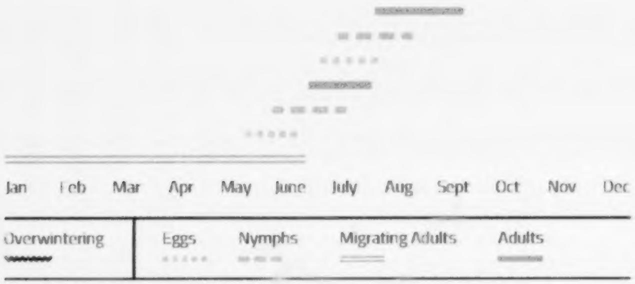
Aster leafhopper – damage (aster yellow infection)
Chrystel Olivier, AAFC

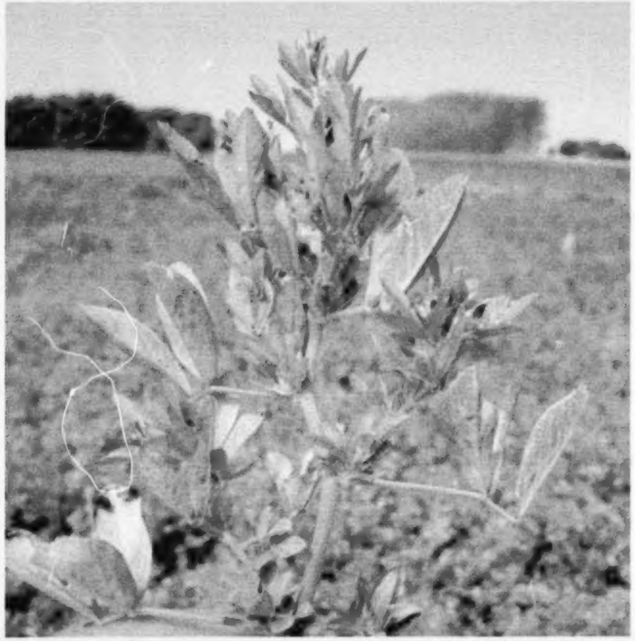


Potato leafhopper – nymph
Frank Peairs, Colorado State University, Bugwood.org

Leafhopper, potato

Empoasca fabae (Harrison)





Potato leafhopper – damage
Bryan Jensen, University of Wisconsin, Bugwood.org

Hosts

Alfalfa, clovers, soybean, dry beans, potatoes, eggplant, rhubarb, celery, and many more food and ornamental plants.

Identification

ADULTS: 3 mm long, yellowish-green, wedge-shaped. Readily fly or hop when disturbed.

MATURE NYMPHS: 3 mm long, pale yellow body and with wing pads. Can be confused with aphid nymphs which walk slower, usually have cornicles, and have ovate bodies rather than wedge-shaped. Also, leafhopper nymphs tend to walk somewhat sideways.

Life Cycle

Potato leafhoppers (PLHs) blow up from the southern U.S. each spring on southerly winds. Adults settle on grasses and forages (e.g. winter wheat, alfalfa) where they mate before moving to summer food hosts to lay eggs. Populations die off in the fall. Two and possibly three overlapping generations per year (4-5 weeks/generation), depending on numbers arriving and arrival time in the spring, and seasonal weather conditions.

Feeding Damage

ADULTS AND NYMPHS: Both stages feed by piercing leaf tissue and sucking sap, however nymphs are more harmful. The saliva of both stages is toxic to plants.

DRY BEANS: Leaves turn from green to yellow to reddish brown, stunted growth and death.

SOYBEANS: Yellowish patches on the leaves with crinkling and cupping, often confused with herbicide damage. Plant growth is also stunted if left uncontrolled. Later seeded crops are at greatest risk of crop loss.

ALFALFA: Stunted growth, yellowing of leaves in a V-shaped pattern starting at the tip of a leaflet. New plantings are most at risk as well as regrowth under hot, dry conditions.

Similar Species

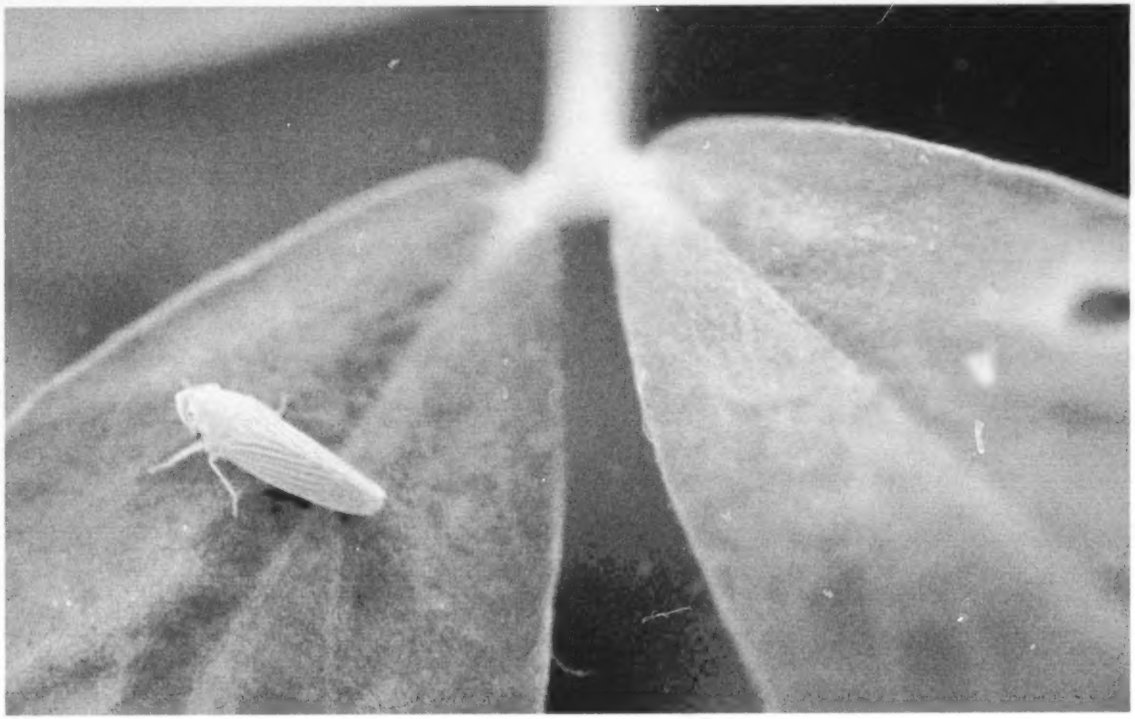
Aster leafhopper (p. 45). There are many species of leafhoppers in and around crops.

Leafhopper, potato
(continued)

Monitoring/Scouting

ALFALFA: Scout at intervals of 5–7 days, beginning after first cut. Take 20 180° sweeps from five areas of the field beginning in late June. Avoid field edges. Determine the average number of PLHs per sweep.

DRY BEANS: Following an "X" pattern across the field, at each of 10 sites spaced by at least 50 m, pick 5 trifoliate leaves that are newly and fully expanded from the centre of the plant canopy. Record and average the number of nymphs/trifoliate for the field.



Potato leafhopper – adult
Steve L. Brown, University of Georgia, Bugwood.org

Economic Threshold

ALFALFA: <9 cm high, 0.2 adults/sweep; 9–<15 cm, 0.5 adults/sweep; 15–<25 cm, 1 adult or nymph/sweep; 25–<36 cm, 2 adults or nymphs/sweep.

DRY BEANS: 4th trifoliate stage—1 nymph or adult/trifoliate; first bloom—2 nymphs or adults/trifoliate.

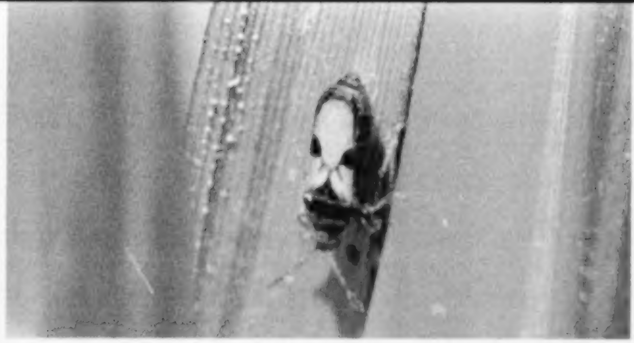
SOYBEAN:
V1 stage—1.4 to 3.6 leafhoppers/plant
V2 stage—3.0 to 7.8 leafhoppers/plant
V3 stage—4.7 to 12.2 leafhoppers/plant
V4 stage—6.5 to 16.7 leafhoppers/plant
R4 stage—9 leafhoppers/plant
R7 stage—18 leafhoppers/plant

Management Options

BIOLOGICAL: Natural enemies do not have a major impact on leafhopper numbers. Green lacewings (p. 139) consume leafhopper nymphs.

CULTURAL: Seed annual crops as early as possible as larger plants are less affected by infestations. Cutting alfalfa early will potentially reduce egg, nymph, and adult populations. Plant leafhopper-resistant alfalfa cultivars. Hairless (glabrous) soybean varieties are more susceptible to leafhopper feeding than varieties with hairs.

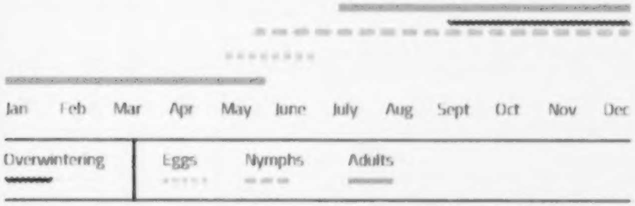
CHEMICAL: None registered in Canada.



Chinch bug – adult
Natalie Hummel, Louisiana State
University AgCenter, Bugwood.org

Chinch bug

Blissus leucopterus leucopterus (Say)



Chinch bug – adult
Natalie Hummel, Louisiana State
University AgCenter, Bugwood.org

Hosts

Wheat, barley, oats, and corn; turf grasses such as foxtail, fescue, bentgrass, bluegrass; brome grass and wild rye grass do not support development.

Identification

ADULTS: 4–6 mm long; colour from dark brown to black and red legs; transparent wings forming "X" pattern across over back.

MATURE NYMPHS: Distinctive white band across abdomen near the ends of the black wing buds.

Life Cycle

Overwinter mainly as adults or mature nymphs under leaf litter in no-till fields, fence rows, ditches, etc. outside fields. Adult fly/nymphs walk to nearby cereal crops in spring; females lay eggs in the soil or behind leaf sheaths. One generation per year.

Feeding Damage

ADULTS AND NYMPHS: Pierce leaf tissue to extract contents, causing yellowing or browning of leaves, progressing from lower to upper leaves. Saliva disrupts water flow in the plants, causing wilting and reduced growth. Severely infested seedlings can die, especially in drought conditions. Damage starts from field margins. Seed yield and quality is reduced. Adults and nymphs will move to other hosts as cereal hosts mature. New adults will feed on winter wheat in the fall under warm conditions without causing injury to young plants.

Similar Species

Hairy chinch bug (*B. leucopterus hirtus* Montandon) and the western chinch bug (*B. occiduus* Barber).

Monitoring/Scouting

None developed.

Economic Threshold

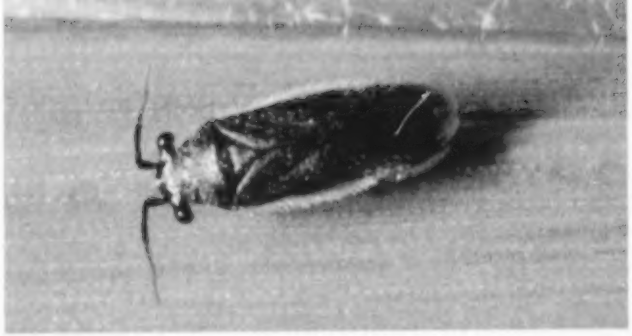
None established.

Management Options

BIOLOGICAL: Big-eye bugs (p. 126) and an egg parasitoid (*Eumicrosoma beneficum* Gahan), spiders (pp. 111–114), damsel bugs (p. 127), and other predators.

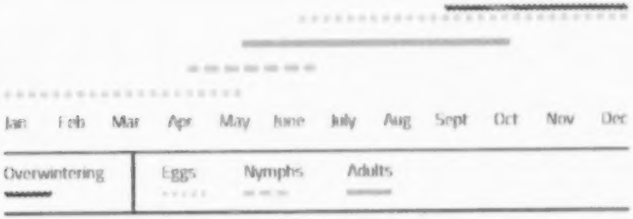
CULTURAL: Maintain optimum plant health to improve tolerance to attack; plant cereal crops earlier when possible; rotate or intermix crops with leguminous plants.

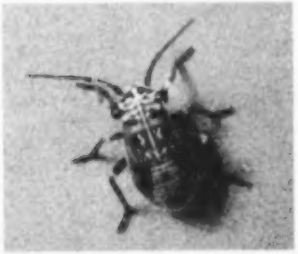
CHEMICAL: None for cereal crops; several for turf grasses.



Black grass bug – *Labops* sp. adult
Julie Soroka, AAFC

Grass bugs, black
Labops spp./*Capsus* spp./*Irbisia* spp.





Black grass bug – *Labops* sp. nymphs
Julie Soroka, AAFC

Black grass bug – damage
Julie Soroka, AAFC

Black grass bug – damage
Bob Hammon, Colorado State University,
Bugwood.org

Hosts

Wheatgrasses are preferred hosts, but will feed on alfalfa, barley, wheat, rye, oats, and range grasses such as brome grass, orchardgrass, and bluegrass; some broadleaved plants are fed on in absence of grasses.

Identification

ADULTS: 4 mm long, blackish gray to black body, some with buff-white margins on the edges of the front wings and whitish markings on the head (e.g. *Labops hesperius* Uhler); all have large, bulging eyes.

MATURE NYMPHS: Resemble adults except for size and presence of wings (although some adults may have reduced non-functional wings).

Life Cycle

One generation per year. Eggs are laid in plant stems. All three stages may be found on the same host plants in early summer. Egg to adult takes 4-5 weeks.

Feeding Damage

ADULTS AND NYMPHS: Both adults and nymphs feed on the same plants. Puncturing leaf tissue causes yellowish to whitish mottled markings on the leaf surface. Damage progresses from the leaf tip to its base; severely infested plants will appear frost-damaged. Plants will not recover under drought conditions resulting in significant loss in forage and seed production. Infestations in cereal crops are usually limited to field margins as females migrate from nearby infested pasture and hay fields. Severe damage to the flag leaves will cause irreversible yield loss. Feeding can also causes grass seed heads to turn white and seed sterility, a condition known as silvertop.

Similar Species

Black grass bugs include *Labops* spp., *Capsus* spp. (e.g. *C. cinctus* (Kolenati)) and *Irbisia* spp., all of which feed on similar hosts and cause similar damage, including silvertop.

Monitoring/Scouting

None.

Economic Threshold

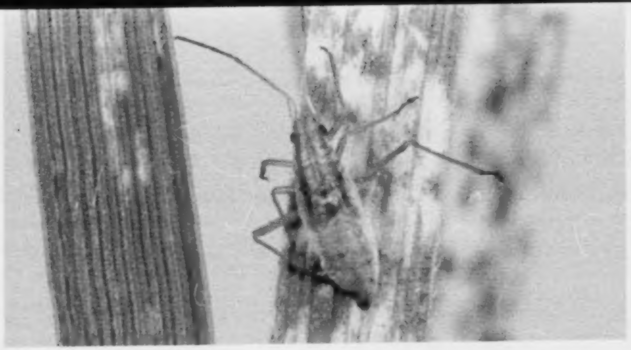
In general, grass fields exhibiting 10% or more silvertop should have remedial action taken the following year. Silvertop, once evident, cannot be treated or reversed in the current season.

Management Options

BIOLOGICAL: Damsel bugs (p. 127) and spiders (pp. 111-114) are common predators.

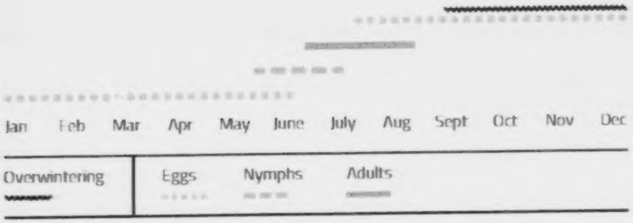
CULTURAL: Post-harvest burning or burning in the spring prior to new growth will destroy many plant bug eggs and adults. Do not burn creeping red fescue fields in the Peace River region because of potential damage to the subsequent seed crop. In this region, burn only after the last seed harvest and prior to entering a rejuvenation cycle. Low-mowing (below 3 cm) and removal of straw following harvest also decreases the incidence of silvertop.

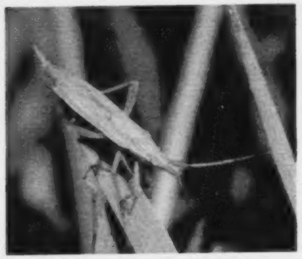
CHEMICAL: Check provincial field crop pest control guides for the latest chemical recommendations.



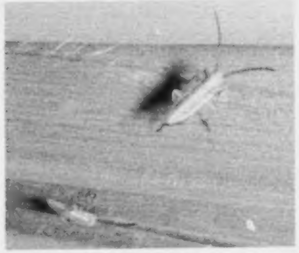
Rice leaf bug – nymph, damage
Julie Soroka, AAFC

Grass bugs, green-tan





Grass bug (*Stenodema* sp.) – adult (similar species)
Julie Soroka, AAFC



Rice leaf bug – nymph
Julie Soroka, AAFC

Hosts

Oats, barley, rye, wheat, corn, and various grasses.

Identification

ADULTS 5.5-7 mm long, narrow uniformly green or tan bodies, some with green legs, red hind tarsi (feet) and red antennae with 3 distinct broad, pale stripes on segment 1 (e.g. the rice leaf bug, *Trigonotylus coelestialium* Kirkaldy).

MATURE NYMPHS 4–5 mm long, similar colouration to adults except with brownish wing pads.

Life Cycle

Overwinter as eggs in grasses within or near cereal crops. Adults fly into young cereal crops to lay eggs in rows within leaf sheathes near the plant base. Once cereal crops are harvested the bugs disperse to grasses, and may feed on winter wheat crops early in the fall. One generation per year.

Feeding Damage

ADULTS AND NYMPHS Both stages feed by piercing leaf and stem tissue to extract plant fluids. Feeding causes some decrease in forage quality and plant growth. Adults will move into nearby seedling cereal crops. Injury includes browning of seedling tips and fecal spotting on leaves, and stunting seedling growth. As cereal crops mature, adults and nymphs will move up to feed on the heads and any green stem tissue just beneath. Grass plant bugs also cause a condition known as silvertop (p. 46), or sterile seed heads, of perennial grasses.

Similar Species

A related species that closely resembles the rice leaf bug is *T. ruficornis* (Geoffroy) which has significantly reduced seed yields of merion bluegrass in northern B.C. Rice leaf bugs could also be confused with three other grass bugs that have similar body shapes but are tan in colour—*Stenodema vicina* (Provancher), *S. trispinosus* Reuter and the meadow plant bug, *Leptopterna dolabrata* (Linnaeus).

Monitoring/Scouting

Sweep grasses surrounding emerging cereal crops for presence of nymphs and adults; monitor crop for immigrating bugs thereafter.

Economic Threshold

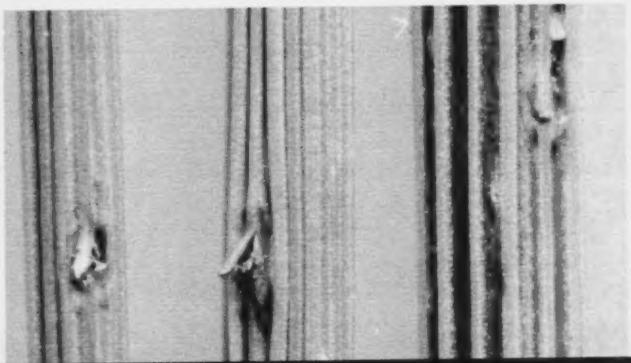
None. Research has shown as few as 1 or 2 adults per seedling can retard seedling growth. Not considered a pest of forage grass production, but in perennial grass seed production thresholds will vary according to seed prices, which fluctuate wildly. In general, grass fields exhibiting 10% or more silvertop should have remedial action taken early in the following year. Silvertop, once evident, cannot be treated or reversed in the current season.

Management Options

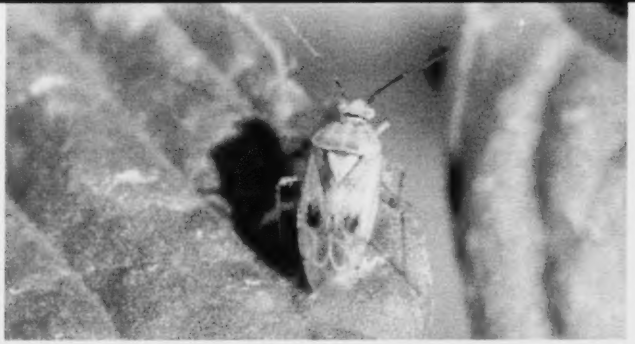
BIOLOGICAL Tachinid fly, *Phasia robertsonii* (Townsend) (p. 123), as well as generalist predators such as damsel bugs (p. 127) and spiders (pp. 111-114). The pteromalid *Trichomalopsis sarcophagae* (Gahan) (p. 137) has been recovered from the rice leaf bug.

CULTURAL Post-harvest burning or burning in the spring prior to new growth will destroy many plant bug eggs and adults. Do not burn creeping red fescue fields in the Peace River region because of potential damage to the subsequent seed crop. In this region, burn only after the last seed harvest and prior to entering a rejuvenation cycle. Low-mowing (below 3 cm) and removal of straw following harvest also decreases the incidence of silvertop.

CHEMICAL Check provincial field crop pest control guides for the latest chemical recommendations.



Rice leaf bug –damage
Julie Soroka, AAFC



Pale legume bug – adult
Whitney Cranshaw, Colorado State University, Bugwood.org

Lygus bugs

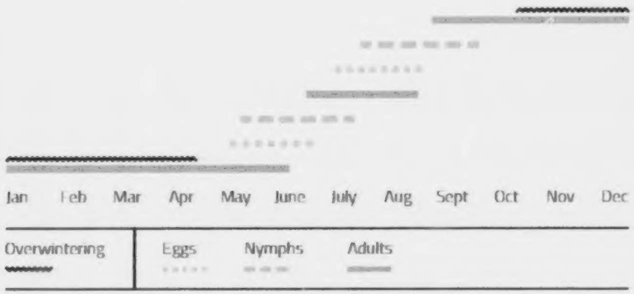
pale legume bug
Lygus elisus Van Duzee

tarnished plant bug
Lygus lineolaris (Palisot de Beauvois)

western tarnished plant bug
Lygus hesperus Knight

Lygus borealis Kelton

Lygus keltoni Schwartz and Foottit



Hosts

Canola, alfalfa, soybeans, sunflowers, and many other cultivated and native plants and weeds.

Identification

ADULTS 6 mm long; pale green to reddish brown to black, uniform to mottled colour; display the distinctive, triangular or "V"-shaped marking in the upper centre of their backs and membranous wingtips.

MATURE NYMPHS Similar colouration to adults but with five black dots on thorax and abdomen. Wing buds are noticeable.

Life Cycle

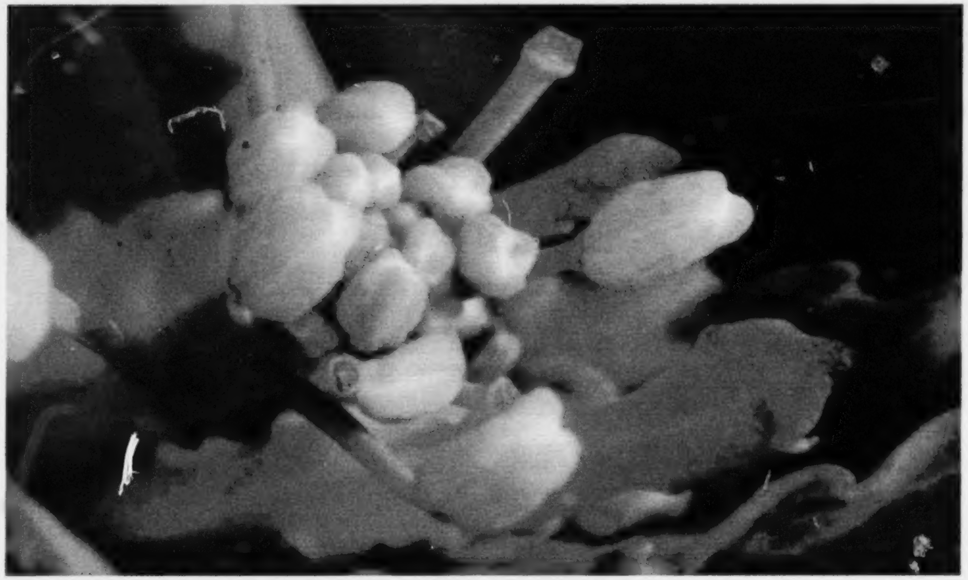
Overwinter as adults under plant debris adjacent to fields. Adults migrate into crops in spring and summer to lay eggs on stems. Adults are strong fliers. Two generations per year in the southern prairies but only one in the northern areas.

Feeding Damage

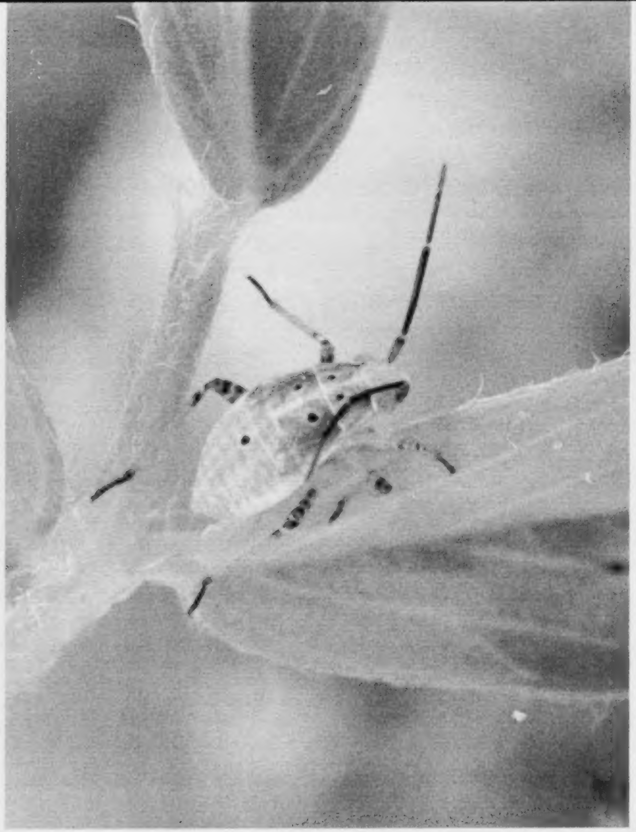
ADULTS AND NYMPHS Attack the new growth and reproductive parts (flower buds, seeds, and pods) of plants by piercing tissue to extract contents; buds turn white and fail to develop, flowers fall without forming pods or pods fall without maturing. Seeds that have been fed on will collapse or shrink, as well as darken, and will lose their quality and viability. Additional loss may occur if flowering is delayed by heavy feeding pressure or drought.

Similar Species

In alfalfa crops, the alfalfa plant bug (*Adelphocoris lineolatus* (Goeze) (p. 53)) may also be present. It is 7–9 mm long with yellowish-green to green colour, green legs with black spots. Nymphs are brown to light green.



Lygus bug – damage
Mike Dolinski, MikeDolinski@hotmail.com



Tarnished plant bug – nymph
Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Monitoring/Scouting

Use a standard 40 cm (15 in.) diameter sweep net to sample crops to determine the need for control actions.

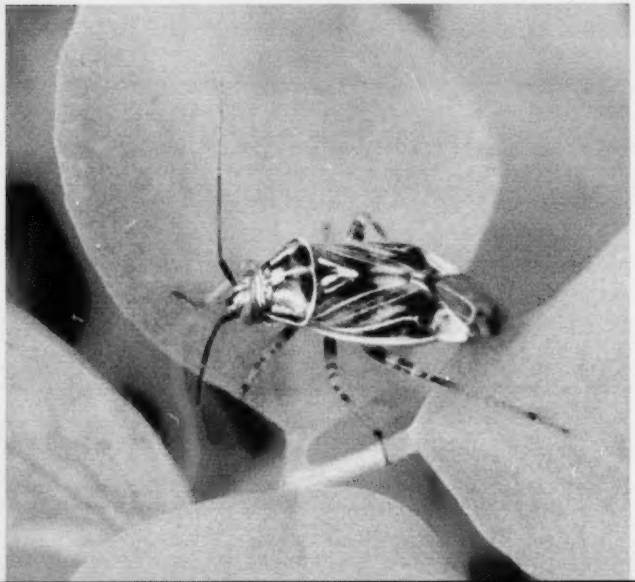
CANOLA Sample at the end of flowering and at early pod ripening when the temperature is >15°C by taking ten 180 degree sweeps at each of 15 sites; record the cumulative total number of lygus caught at each site. Samples can be taken along or near the field margins. Consult the sequential sampling chart posted on the Alberta, Saskatchewan, and Manitoba government and Canola Council of Canada web sites.

SEED ALFALFA Sample crops beginning at the bud stage by taking five 180° sweeps at one site in each 4 ha (10 ac) of crop (minimum 15 sites/field). Record the number of nymphs and adults captured at each site. Also record the number of alfalfa plant bug nymphs and adults captured. Calculate the average number of both lygus bugs and alfalfa plant bugs per sweep.

Economic Threshold

CANOLA Consult the economic threshold charts posted on provincial government web sites. Sprays are not recommended once the seeds have ripened to yellow or brown.

SEED ALFALFA 8 lygus bugs/sweep (40 in five sweeps) or 4 alfalfa plant bugs/sweep (20 in five sweeps) or 5 nymphs/sweep (25 in five sweeps) of any or all species of plant bugs, when the alfalfa is in bud or in bloom.



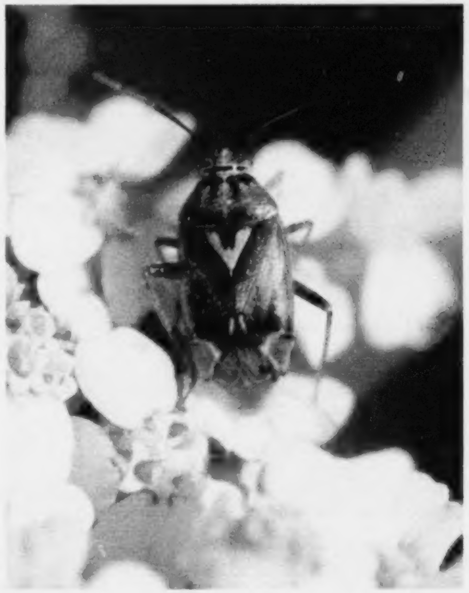
Tarnished plant bug – adult
Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Management Options

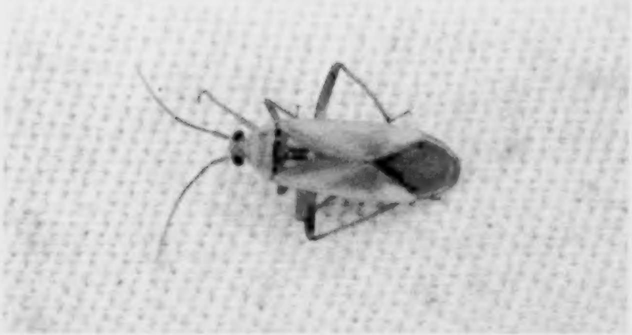
BIOLOGICAL Lygus bugs are attacked by several species of egg and nymphal parasitoids (e.g. the braconids *Peristinus pallipes* (Curtis) and *P. digoneutis* Loan (p. 130)), predatory bugs, and spiders (pp. 111-114). The pteromalid *Trichomalopsis sarcophagae* (Gahan) (p. 137) has been recovered from *L. lineolaris*.

CULTURAL None have been found to be effective.

CHEMICAL One insecticide application at the end of flowering (bloom 90 per cent complete or more) or at the early pod stage should prevent significant yield losses. Consider delaying application if nearby alfalfa crops are being cut which may force lygus bugs to seek other host crops. Insecticides applied against lygus bugs should also control any alfalfa plant bugs present.



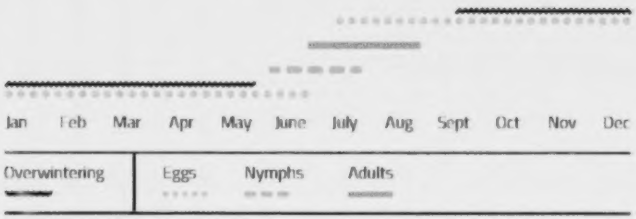
Western tarnished plant bug – adult
Whitney Cranshaw, Colorado State University, Bugwood.org

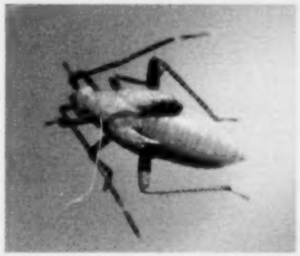


Alfalfa plant bug – adult
Mike Dolinski, MikeDolinski@hotmail.com

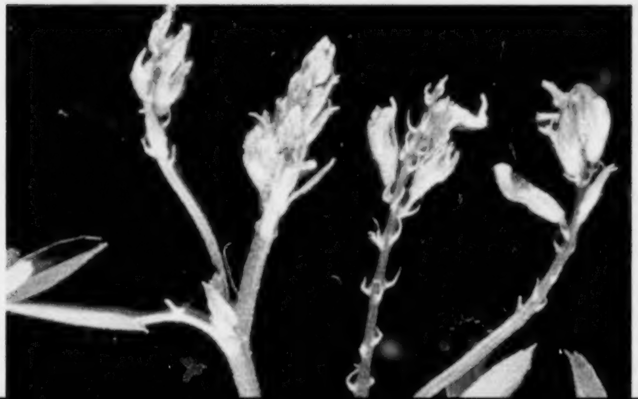
Plant bug, alfalfa

Adelphocoris lineolatus (Goeze)





Alfalfa plant bug – nymph
John Gavloski, Manitoba Agriculture, Food and Rural Development



Alfalfa plant bug – damage
AAFC

Hosts

Alfalfa main host; occasionally red and sweet clover, canola when alfalfa not available.

Identification

ADULTS: 7-9 mm long, 2.5-3 mm wide, yellowish-green to green body with green legs and black spotting on the legs.

MATURE NYMPHS: Resemble adults but smaller, brownish turning to bright green body with small wing pads; last antennal segment is enlarged (club-like) and black.

Life Cycle

Overwinter as eggs in the stems of alfalfa. One generation per year; however, a small second generation can appear later in early, hot summers. New adults will readily disperse to other alfalfa crops, even kilometres away.

Feeding Damage

ADULTS AND NYMPHS: A problem only in seed alfalfa crops where they feed on the flower buds by piercing leaf tissue and injecting a toxin that causes the buds to turn greyish white, shrivel and die. Heavily infested crops will show reduced or few blossoms.

Similar Species

In alfalfa crops, the shorter lygus bugs will likely be present (p. 51). Lygus bugs generally feed later on the flowers and developing seeds. The superb plant bug (*Adelphocoris superbus* (Uhler) (p. 54)) is an occasional pest of seed alfalfa crops. The bright red nymphs and adults easily distinguish it from other plant bugs.

Monitoring/Scouting

Using a standard sweep net (40 cm/15 in. diameter), sample seed alfalfa crops beginning at the bud stage by taking five 180° sweeps at one site in each 4 ha (10 ac) of crop (minimum 15 sites/ field). Record the number of nymphs and adults captured at each site. Also record the number of lygus bug nymphs and adults captured. Calculate the average number of both lygus bugs and alfalfa plant bugs per sweep.

Economic Threshold

ALFALFA PLANT BUG ONLY: Pre-bud stage, 15 nymphs/sweep; bud and bloom, 2-3 nymphs and/or adults/sweep; after bloom, 4 nymphs or 5 adults/sweep.

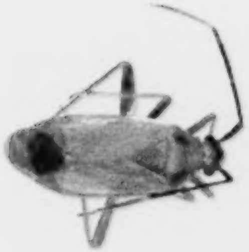
ALFALFA PLANT AND LYGUS BUGS: 8 lygus bugs/ sweep (40 in 5 sweeps) or 4 alfalfa plant bugs/ sweep (20 in 5 sweeps) or 5 nymphs/sweep (25 in 5 sweeps) of any or all species of plant bugs, when the alfalfa is in bud or in bloom.

Management Options

BIOLOGICAL: Alfalfa plant bugs are attacked by several species of egg and nymphal parasitoids, predatory bugs, and spiders (pp. 111-114).

CULTURAL: Burning of stubble and crop debris will kill overwintering eggs. Alternatively, early cultivation to incorporate straw and stubble into the soil will reduce populations.

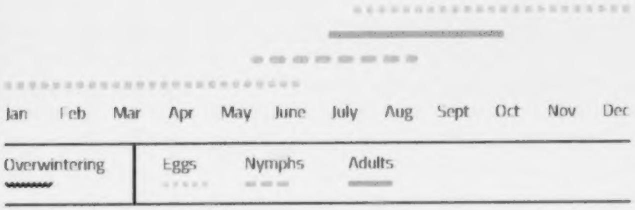
CHEMICAL: Insecticide treatment should be considered if alfalfa plant bug levels threaten developing flower buds. Further treatments are usually not needed. Pre-bloom treatments can be harmful to beneficial insects and pollinators. If insecticide application coincides with bloom of hawksbeard or dandelion, use a chemical with a short residual period, avoid insecticide drift into non-target locations, and spray in the evening after bees have ceased foraging.



Superb plant bug
Tyler Wist, AAFC

Plant bug, superb

Adelphocoris superbus (Uhler)



Hosts

Alfalfa is primary host; can reproduce on Canada thistle.

Identification

ADULTS: 8 mm long, narrow (2.5 mm), bright red thorax and wings with black marking down back and under wings.

MATURE NYMPHS: 7 mm long, red bodies without black markings or wings.

Life Cycle

Overwinters as eggs that are laid in alfalfa plants in Aug–Sept. Hatching begins in late May.

Feeding Damage

ADULTS AND NYMPHS: Both stages pierce tissue of developing buds to extract plant fluids, causing reduced growth, destroyed or blasted flower buds, abortion of flowers, reduced pod formation, shrivelled seeds with poor germination, and reduced seed yields. Some of the damage may be caused by the saliva injected during feeding.

Similar Species

None

Monitoring/Scouting

Use a sweep net to check at least 10 sites in the alfalfa crop in the early bud stage for presence of the 2-4 mm long, reddish nymphs.

Economic Threshold

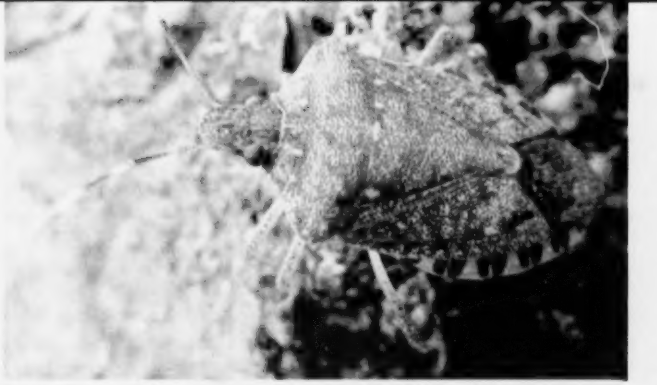
4 bugs/sweep.

Management Options

BIOLOGICAL: No specific natural enemies identified – see also Integrated Pest Management (IPM) section (p. 3).

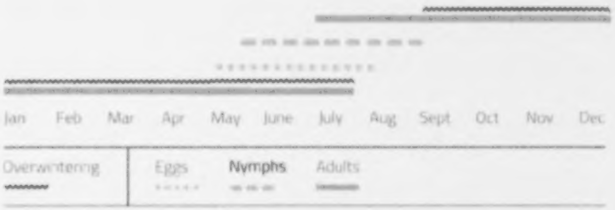
CULTURAL: Burn alfalfa stubble in the spring to reduce overwintering eggs. Some resident natural enemies will be impacted. Eliminate Canada thistle in and around alfalfa crops.

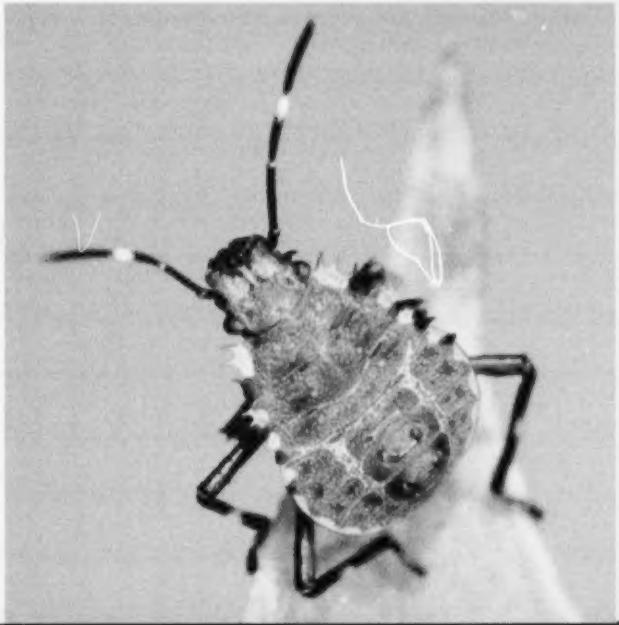
CHEMICAL: Not recommended for hay crops. For alfalfa grown for seed, sprays applied against other pests when the crop is in early bud stage will control this pest.



Brown marmorated stink bug – adult
CC-BY 2.0 Katja Schulz

Stink bug, Brown marmorated
Halyomorpha halys (Stål)





Brown marmorated stink bug – nymph
CC 2.0-BY Katja Schulz

Hosts

Field corn and soybean are preferred field crop hosts for nymphs and adults. Infestations have been reported on rape, pea, sunflower and cereals in the USA. Also attacks tree fruits, berries, vegetables and many ornamental trees and shrubs. Plants with fruiting bodies, buds, or pods are most attractive to adults for feeding and egg-laying.

Not known to be established on the Prairies but detected in the BC Southern Interior in 2016.

Present in Ontario and Quebec, and throughout the U.S.

Identification

ADULTS: Stout, shield-shaped, 13-17 mm long mottled brownish grey body with alternating brown and white markings along the edge of the abdomen extending beyond the winds. There are two distinctive white bands on each antenna. Legs are also mottled brownish-grey with faint white banding. Underside of body somewhat whitish in colour. The "shoulders" of the pronotum (triangular body section behind head) lack spines

MATURE NYMPHS: Brownish-red shield-shaped 12 mm long body with white markings on the exposed abdomen (no wings present) and faint white banding on legs. Eyes are a deep red. There are two white bands on each antenna. Small spines are present on the femurs and sides of the pronotum in later instars (3rd to 5th); a single spine is present in front of each eye.

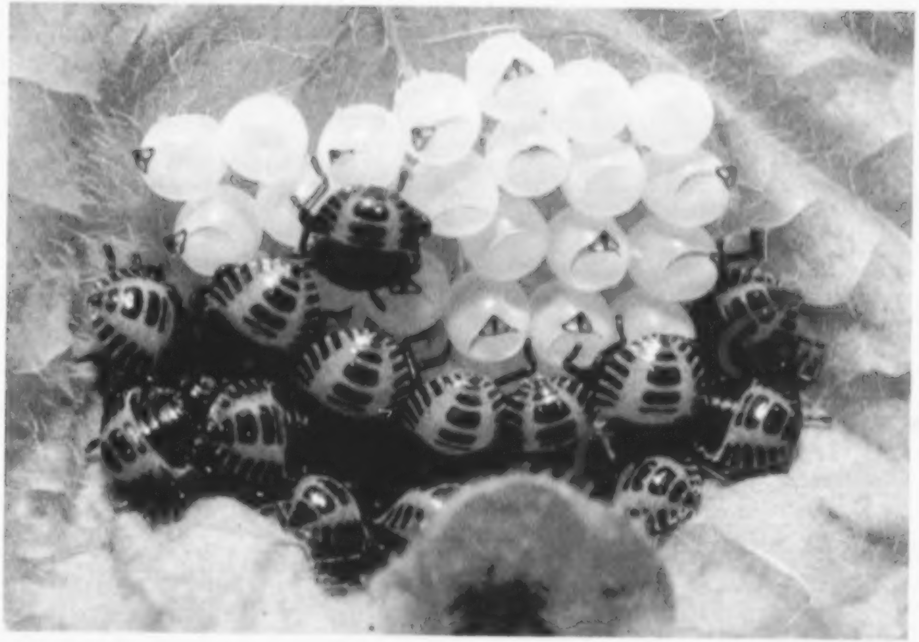
Life Cycle

Adults overwinter in buildings and other protected locations that they emerge from in mid- to late spring. About 2 weeks later, females mate and disperse to lay from 200 to 400 white barrel-shaped eggs in clusters of 20-30 eggs on the undersides of host plant leaves. Eggs hatch in 4-5 days. Because the egg-laying period is so long, all five nymphal instars and adults are present throughout the summer. Nymphs mature in about 5 weeks depending on temperature. New adults begin seeking suitable overwintering sites in late summer. Only one generation is expected per year.

Feeding Damage

ADULTS AND NYMPHS: Extract plant fluids by piercing and sucking developing seeds with mouth parts. In soybean, the damage appears as shrivelled seeds and flattened pods. In corn, damaged kernels are discoloured and shrunken, similar to wheat. In late summer to early fall, infested soybean plants can display a "stay green" syndrome due to a delay in senescence. Most feeding damage occurs in the outer 10-12 m of crop as a result of adult immigration. Adults are also a nuisance in the spring when they congregate on buildings before dispersing and also because of the disagreeable 'stink' when squashed.

Stink bug, Brown marmorated
(continued)



Brown Marmorated Stink Bug - nymphs and eggs
CC 3.0-BY David R. Lance, USDA APHIS PPQ, Bugwood.org

Similar Species

There are many species of native stink bugs that occasionally visit soybean and field corn crops, especially towards the end of the summer when native host plants die off. Examples are brown stink bugs (*Euchistus servus* Say), consperse stink bugs (*E. consperus* Rolston and related species), and rough stink bugs (*Brochymena* spp.). However, these and other stink bug species do not have the white bands on their antennae nor do they congregate on buildings in the spring like boxelder bugs (*Boisea* spp.) and the western conifer seed bug (*Leptoglossus accidentalis* (Barber)).

Monitoring/Scouting

Use sweep nets to sample the margins (especially nearest to buildings and woodlots) of host crops for adults and nymphs. For soybean, sample during the R4 (fully elongated pods) to R6 (fully developed seed). For corn, examine crop margins during ear formations stages R3 and R4. Collect and store any suspect stink bug specimens for examination by specialists. Sample wheat during the milk to soft dough stages. Researchers have identified an aggregation pheromone which will aid in earlier detection of this pest.

Economic Threshold

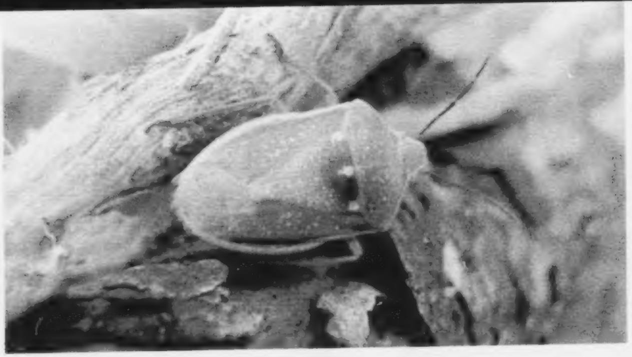
None established for corn, soybean, or wheat.

Management Options

BIOLOGICAL Surveys in the US revealed several species of native predatory insects and parasitoids attack this pest. Efforts are underway to evaluate Asian parasitoids combined with using field insectaries for native natural enemies to provide a biological control component.

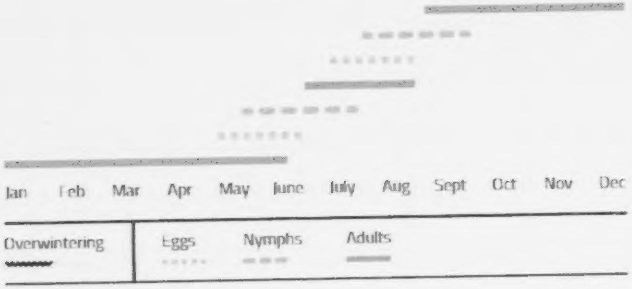
CULTURAL None developed yet.

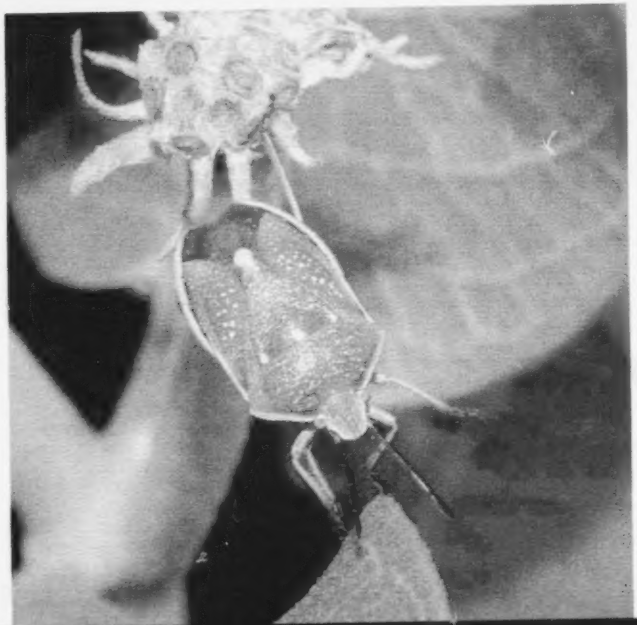
CHEMICAL Control products are registered for control or suppression on corn, cereals, and dry peas. Check the labels for approved crops.



Say stink bug – adult
Kati Fleming

Stink bug, Say
Chlorochroa sayi (Stål)





Say stink bug – adult
William M. Ciesla, Forest Health Management International, Bugwood.org

Hosts

Wheat is major host; alternate hosts include barley, oats, and various native plants and weeds.

Identification

ADULTS: 8–10 mm long, shield-shaped, mainly green with a pale orange stripe around the outer edge of the body; scutellum has four yellow spots.

MATURE NYMPHS: Green bodies with similar shape as adults, without wings and distinctive spots.

Life Cycle

Overwinter as adults within plant debris in fields and field borders. Females lay small, barrel-shaped eggs in clusters or rows on plant stems or surfaces. One or two generations per year (6–8 weeks eggs to adult), depending on the length of the growing season.

Feeding Damage

ADULTS AND NYMPHS: Pierce developing kernels to remove contents. They feed actively in the morning and late afternoon. Feeding at the boot stage stunts the plants, and feeding just before heading reduces kernel numbers/head, kernel weight, and can discolour kernels. Yield losses are significant when wheat is attacked just before, or up to 5 days after, the heads emerge. Shriveled, deformed, and light grains are symptomatic of Say stink bug feeding. Damage is slight when fed upon at the dough stage.

Similar Species

Uhler's stink bug (*Chlorochroa uhleri* (Stål) (p. 58)) has different markings on the back. Other non-green species of stink (shield) bugs are present on native plants throughout the season; once native plants dry up, the bugs will seek any green plants to feed on until they seek overwintering sites.

Monitoring/Scouting

None developed.

Economic Threshold

None established.

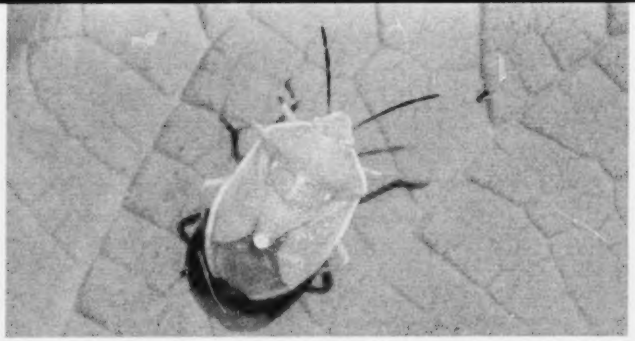
Management Options

Specific management for the Say stink bug is seldom necessary.

BIOLOGICAL: Specific natural enemies are not known that can regulate pest populations.

CULTURAL: Eliminate weed hosts in and around wheat fields during the spring to reduce attracting females into the area.

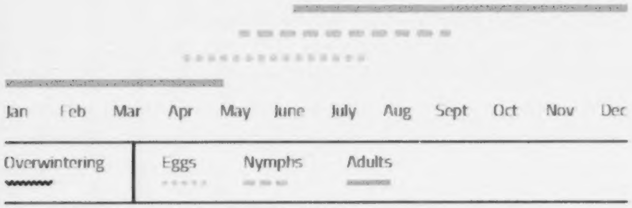
CHEMICAL: Registered products available but seldom necessary.

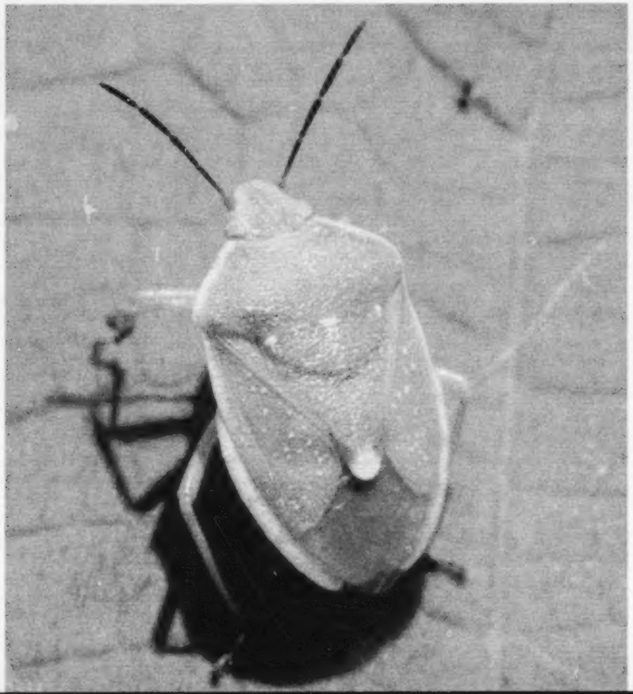


Uhler's stink bug – adult
Chris Hedstrom, Oregon Department of Agriculture

Stink bug, Uhler's

Chlorochroa uhleri (Stål)





Uhler's stink bug – adult
Chris Hedstrom, Oregon Department of Agriculture

Hosts

Wheat, potato; Russian thistle is a preferred weed host.

Identification

ADULTS: 8 mm long, greenish thorax and wing covers speckled with whitish spots, rimmed by a whitish stripe, and two distinctive whitish spots at the front and end of the scutellum.

Life Cycle

Overwinters as adults under plant debris; adults feed and mate on emerging plants before flying to host crops to lay eggs. Russian thistle can act as a spring host from which new adults fly to crop hosts as the Russian thistle dries down. One generation per year.

Feeding Damage

ADULTS AND NYMPHS: Feeding kills the growing points in cereals which can be mistaken for herbicide damage; little obvious damage to Russian thistle.

Similar Species

Other species of *Chlorochroa* are present in Western Canada (p. 57). Several non-green species of stink (shield) bugs feed on native plants throughout the season; once native plants dry up, the bugs will seek any green plants to feed until they seek overwintering sites. If stink bug is present (adult is mainly green with a pale orange stripe around the outer edge of the body; scutellum has four yellow spots), it is at levels below detection or worry.

Monitoring/Scouting

Look for signs of damage. Make several dozen sweeps with a standard sweep net if you suspect Uhler's stink bug is present - concentrate on the field margins. However, because it is usually only a minor, late-season pest, attacking secondary tillers, it normally has little impact on yield making monitoring and control not worthwhile.

Economic Threshold

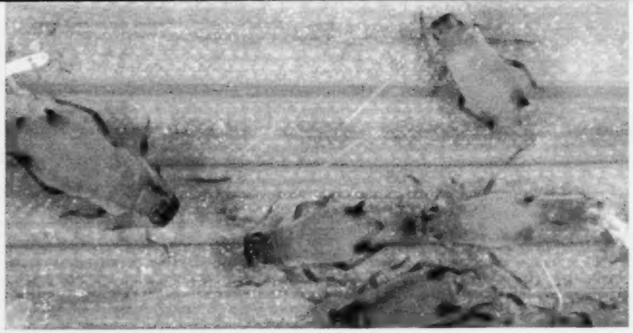
None established.

Management Options

BIOLOGICAL: Specific natural enemies are not known that can regulate pest populations.

CULTURAL: Eliminate weed hosts in and around crop fields during the spring to reduce attracting females into the area.

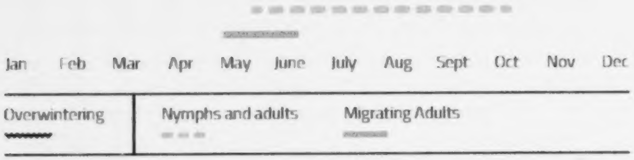
CHEMICAL: Registered products available but seldom necessary.



Corn leaf aphid – adult, nymph
Indian Council of Agricultural Research-National Bureau of Agricultural Insect Resources (www.nbair.res.in)

Aphid, corn leaf

Rhopalosiphum maidis (Fitch)



Corn leaf aphid – damage
Department of Plant Pathology Archive,
North Carolina State University, Bugwood.org

Hosts

Barley, corn, occasionally winter wheat; wild and cultivated grasses.

Identification

ADULTS: 1.6–2 mm long, blue-green or gray with black legs, cauda and short broad black cornicles surrounded by a dark spot around their bases.

MATURE NYMPHS: Similar appearance to adults but smaller.

Life Cycle

Passes the winter on fall planted and volunteer barley and corn and grasses in the southern U.S. It migrates north in the spring, and passes through several generations during migration. Once arrived, it colonizes available host crops and passes through several asexual generations before dying off in the fall. Winged females are produced throughout the summer to seek out new hosts to colonize. Populations die off in the fall.

Feeding Damage

ADULTS AND NYMPHS: Are a vector of barley yellow dwarf virus. Produce sticky clear "honey dew" which supports growth of black sooty mold. Feeding causes mottling and discoloration of leaves. Heavily infested leaves turn red or yellow, shrivel, and die. The important damage usually occurs during and after flowering. Barley is not susceptible to damage from high infestations after the boot stage. Feed on corn tassels and silks.

Similar Species

See descriptions of other species of grain aphids.

Monitoring/Scouting

Prior to the soft dough stage, count the number of aphids present on each of 20 randomly selected tillers at 5 sites across a zig-zag transect of the field. Calculate the average number/tiller.

Economic Threshold

SMALL GRAINS: 12–15 aphids/stem prior to the soft dough stage.

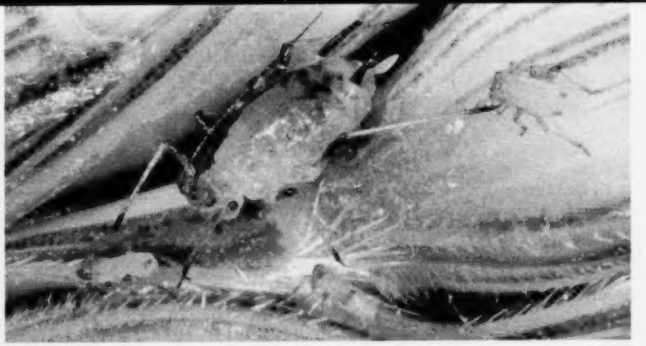
FIELD CORN: The critical period for injury by corn leaf aphid is during tassel emergence through pollination. Treatment is suggested only when 50% of the corn plants have 100+ aphids per plant during tassel emergence and plants are drought stressed.

Management Options

BIOLOGICAL: Several species of parasitoids (e.g. *Aphidius smithii* Sharma et Subba Roa, p. 129), predators (e.g. green lacewings, p. 139; snakeflies, p. 140), and fungal pathogens attack this aphid.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

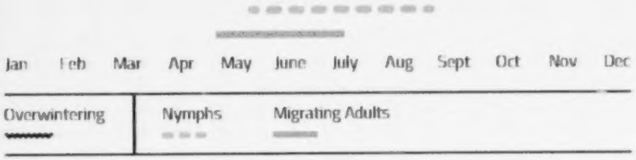
CHEMICAL: Apply products least toxic to natural enemies if treatments are required.



English grain aphid – adult, nymph
Tyler Wist, AAFC

Aphid, English grain

Sitobion (Macrosiphum) avenae (Fabricius)



Hosts

Wheat, barley, oats, rye, canaryseed.

Identification

ADULTS: 1.5-2 mm long, bright green to yellowish-green to reddish-brown with long black legs and cornicles; antennae are as long as or longer than its body.

MATURE NYMPHS: Similar appearance to adults but smaller.

Life Cycle

Not known to overwinter in Canadian prairies; blow in from U.S. Several nymphal generations are produced asexually until late summer. Populations die off in the fall.

Feeding Damage

ADULTS AND NYMPHS: They are very efficient vectors of barley yellow dwarf virus. Feed on leaves of winter cereals in the fall; in the spring colonize leaves then move to the heads to feed on developing kernels, causing some to shrivel. Populations drop quickly as heads mature.

Similar Species

See greenbug (p. 70).

Monitoring/Scouting

Prior to the soft dough stage, count the number of aphids present on each of 20 randomly selected tillers at 5 sites across a zigzag transect of the field. Calculate the average number/tiller. In canaryseed, the head should be bent and closely inspected for aphids hiding inside along the small stem.

Economic Threshold

SMALL GRAINS: 12-15 aphids/stem prior to the soft dough stage.

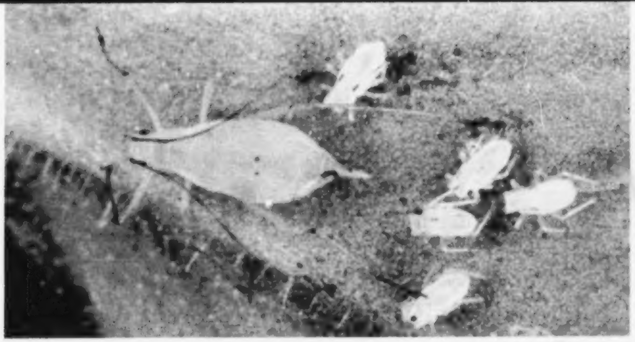
CANARYSEED: A nominal threshold of 10–20 aphids on 50% of the stems prior to the soft dough stage.

Management Options

BIOLOGICAL: Similar to other aphid pests, several species of parasitoids (e.g. *Aphidius avenaphis* (Fitch) (p. 129), *A. ervi Halida* (p. 129), *A. Smithi* Sharma et Subba Rao (p. 129)), predators (especially lady beetles (p. 116), but also green lacewings (p. 139) and snakeflies (p. 140)), and fungal pathogens attack this aphid.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

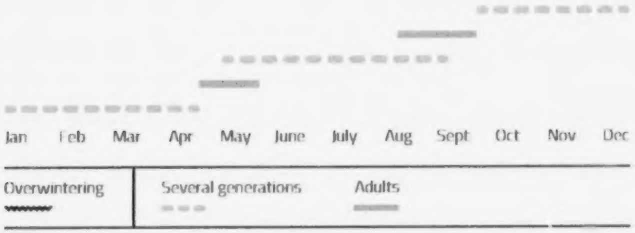
CHEMICAL: Apply products least toxic to natural enemies if treatments are required.

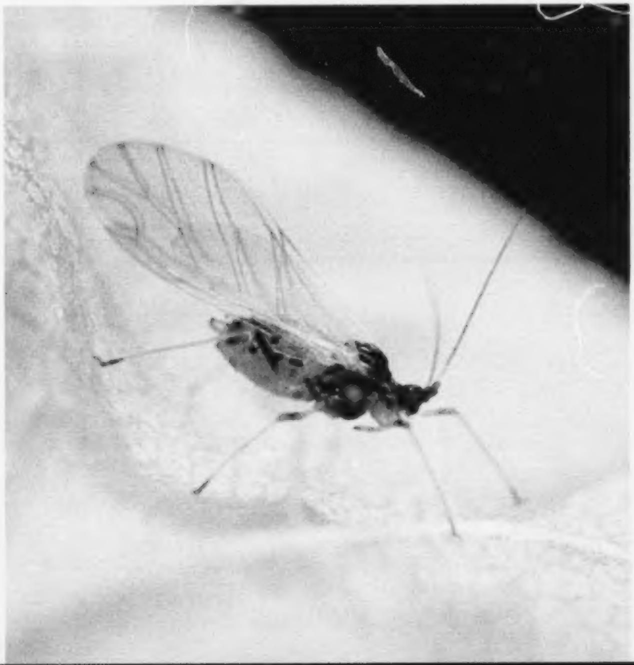


Green peach aphid – adult, nymph
David Cappaert, Michigan State University, Bugwood.org

Aphid, green peach

Myzus persicae (Sulzer)





Green peach aphid – winged adult
Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Hosts

Canola, potato, many other field and greenhouse vegetable and floricultural crops, and tree fruits.

Identification

ADULTS: 1.8 to 2.3 mm long, egg-shaped body with a translucent yellow-green abdomen with a dark patch on the back; the tips of the cornicles are slightly swollen, and the caudal segment is rounded rather than pointed. The bases of the antennae have prominent, inwardly directed tubercles (like a bottle cap opener). Winged adults have a black head and thorax.

MATURE NYMPHS: Similar appearance to adults but smaller; those that become winged females may be pinkish.

Life Cycle

Locally overwinter on host plants in production and display greenhouses, or root houses, from which winged females escape to summer hosts where several generations are produced over the summer (10-14 days/generation). Others migrate up from the U.S each spring on southerly winds. Winged forms are produced during the summer when colonies get overcrowded or the host plant quality declines. Field populations die off with the first fall frosts; winged females migrate back to greenhouses and other plant propagation/storage sites to overwinter.

Feeding Damage

ADULTS AND NYMPHS: Highly efficient vectors of the potato leaf roll and rugose mosaic (PVY) viruses. Viruses are distributed to susceptible crops by winged females seeking new hosts. All stages inject a toxin during feeding, which causes leaf deformities, streaking, and even leaflet death.

Similar Species

See the potato aphid (p. 64). The large body size and elongated shape of the potato aphid distinguish it from the smaller oval-bodied green peach aphid.

Monitoring/Scouting

POTATOES: Starting in early July, examine 25 lower canopy leaves from each of 4 areas in the field. Count the number of green peach aphids (GPA) on each compound leaf (use a hand lens if necessary to identify them from potato aphids).

Economic Threshold

SEED POTATOES: 3 to 10 GPA/100 leaves.

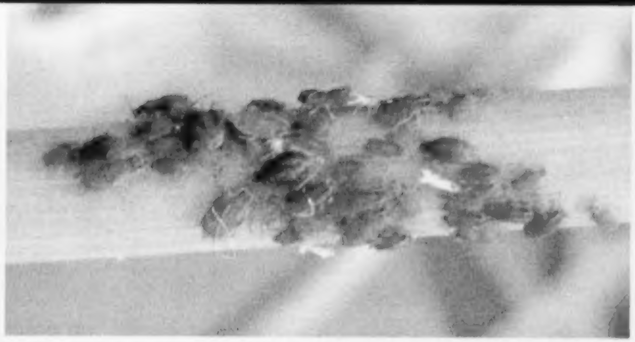
PROCESSING POTATOES: 30-100 GPA/100 leaves.

Management Options

BIOLOGICAL: Several species of predators (green lacewing (p. 139), snakefly (p. 140)) and parasitoids (*Aphidius colemani* Viereck (p. 129), *A. matricariae* Haliday (p. 129), *A. ervi* Haliday (p. 129), *A. smithi* Sharma et Subba Rao (p. 129)) as well as pathogenic fungi attack this widespread pest.

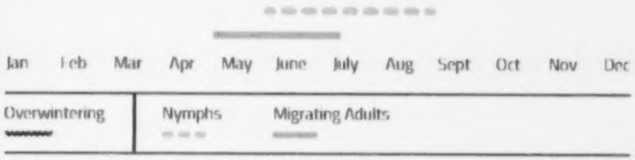
CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

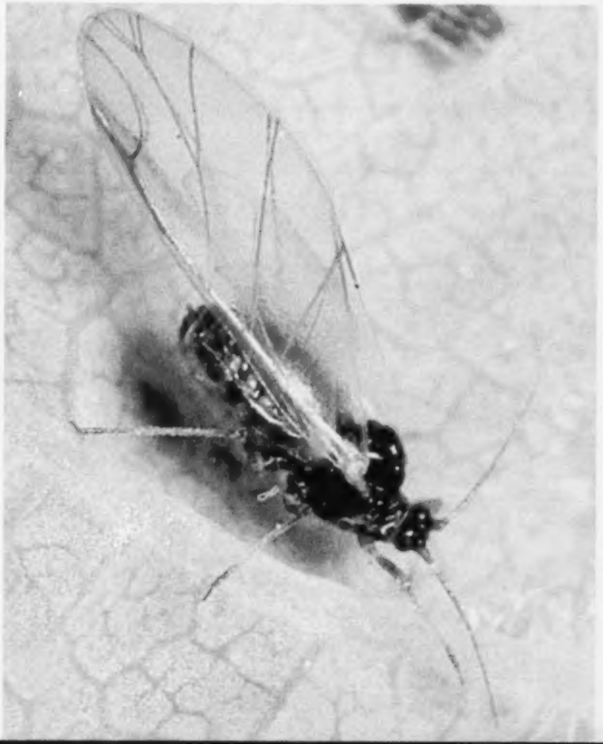
CHEMICAL: Control is rarely required in commercial crops. Seed potato crops must be protected from infection by viruses transmitted by this species. It has a very broad scope of insecticide resistance and care must be taken to rotate insecticide groups to avoid developing resistance.



Oat-birdcherry aphid – adult, nymph
John Gavloski, Manitoba Agriculture, Food and Rural Development

Aphid, oat-birdcherry
Rhopalosiphum padi (Linnaeus)





Oat-birdcherry aphid – winged adult
Andrew Jensen, Flickr

Hosts

Wheat, barley, oats, canaryseed.

Identification

ADULTS: 2 mm long, olive-green with black antennae and cornicles, and a red-orange patch between and around the base of each cornicle.

MATURE NYMPHS: Nymphs turn from pale yellowish green to dark olive as they mature.

Life Cycle

Not known to overwinter in Canadian prairies; blow in from U.S. Several nymphal generations are produced asexually until late summer. Populations die off in the fall.

Feeding Damage

ADULTS AND NYMPHS: Although feeding causes no yellowing or other visible damage to wheat plants, heavy infestations can reduce grain quality and affect protein content and test weight. Spring wheat is more susceptible to injury than winter wheat. They are very efficient vectors of barley yellow dwarf virus which can stunt barley and oat plant growth and reduce seed weights in some varieties. Large colonies on wheat plants past the boot stage can cause the flag leaf to twist into a corkscrew shape that can trap the awns, resulting in "fish-hooked" heads.

Similar Species

See descriptions of other species attacking wheat (p. 59, p. 60).

Monitoring/Scouting

Prior to the soft dough stage, count the number of aphids present on each of 20 randomly selected tillers at 5 sites across a zig-zag transect of the field. Calculate the average number/tiller. In canaryseed, the head should be bent and closely inspected for aphids hiding inside along the small stem.

Economic Threshold

SMALL GRAINS: 12-15 aphids/tiller prior to the soft dough stage.

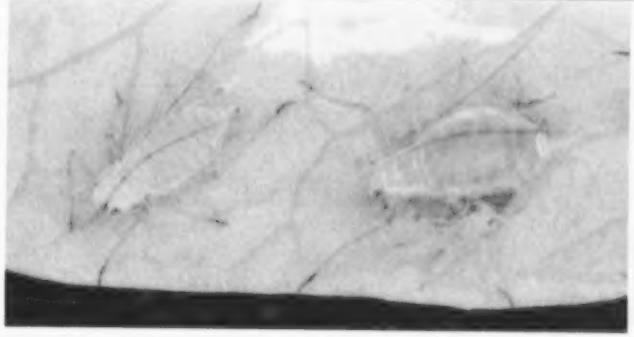
CANARYSEED: A nominal threshold of 10-20 aphids on 50% of the stems prior to the soft dough stage.

Management Options

BIOLOGICAL: Several species of parasitoids (*Aphidius colemani* Viereck (p. 129), *A. smithi* Sharma et Subba Rao (p. 129)), predators, (green lacewing (p. 139), snakefly (p. 140) and fungal pathogens attack this aphid.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

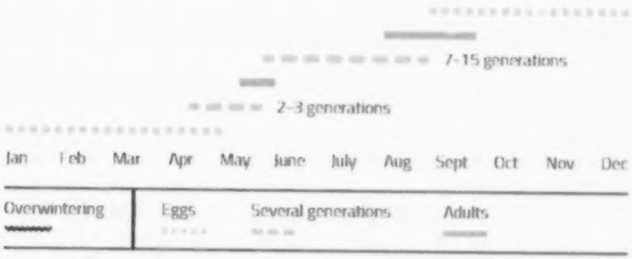
CHEMICAL: Apply products least toxic to natural enemies if treatments are required.

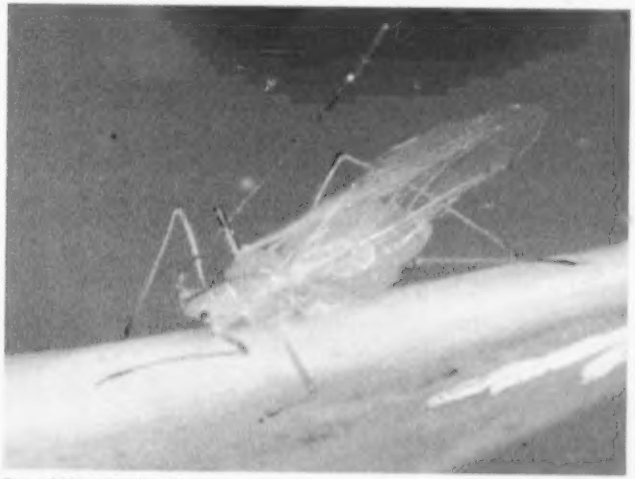


Pea aphid – adult, nymph
Mike Dolinski, MikeDolinski@hotmail.com

Aphid, pea

Acyrthosiphon pisum (Harris)





Pea aphid – winged adult
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

Field peas, alfalfa, broad beans, chickpeas, clover, lentils.

Identification

ADULTS: 3-4 mm long, light to dark green, pear shaped with long legs; each antennal segment tipped by a black band.

MATURE NYMPHS: Similar appearance to adults but smaller.

Life Cycle

Overwinter as eggs on leaves and stems of perennial legumes such as the crowns of clover or alfalfa; 23 generations are produced asexually before winged females migrate to summer crop hosts where several generations are produced over the summer. Colonies are generally less dense than other species attacking field crops. Winged sexual forms are produced in late summer that mate and females return to winter hosts to lay eggs.

Feeding Damage

ADULTS AND NYMPHS: On peas, feeding in the flowering and early pod stage can result in lower yields due to less seed formation and smaller seed size. Protein content and other quality issues do not appear to be affected. On alfalfa, it prefers to feed on stems and newly expanding leaves. Pea aphids may turn leaves yellow and stunt overall plant growth when present in moderate numbers (50-100 per stem). In southern Alberta, infested alfalfa produced less hay, usually contained less carotene, and was more susceptible to winter killing.

Similar Species

See descriptions of grain aphids (p. 59, 60, 62).

Monitoring/Scouting

Beginning when 50-75% of the pea plants are in flower, take five 180° sweeps in 5 locations or check at least five, 8-inch (20 cm) plant tips along at least four well-spaced (50m/150 feet) stops in the field. Calculate the average number of aphids/plant tip or sweep.

Economic Threshold

PEAS: Consult provincial government web site for recommended thresholds for peas that consider crop value and cost of treatment in relation to aphid numbers.

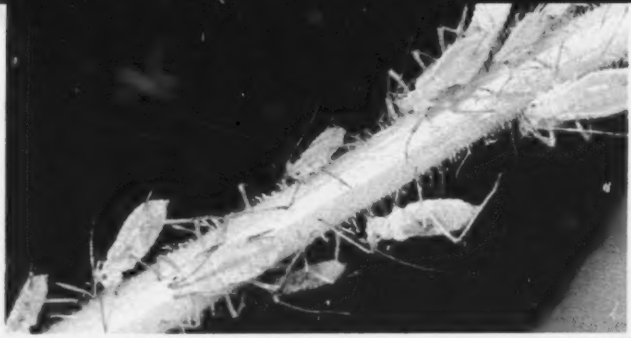
SEED ALFALFA: Alberta-100 to 200/90° sweep; Saskatchewan and Manitoba-100 to 200/180° sweep when dryland crop is moisture-stressed, or until mid-August.

Management Options

BIOLOGICAL: Several species or predatory insects (green lacewing (p. 139), snakefly (p. 140))and parasitoids (*Aphidius matricariae* Haliday (p. 129), *A. ervi* Haliday (p. 129), *A. smithi* Sharma et Subba Rao (p. 129)) as a well as a fungal pathogen attack pea aphids.

CULTURAL: Seeding early in the spring may reduce yield loss due to pea aphids in some cultivars of peas.

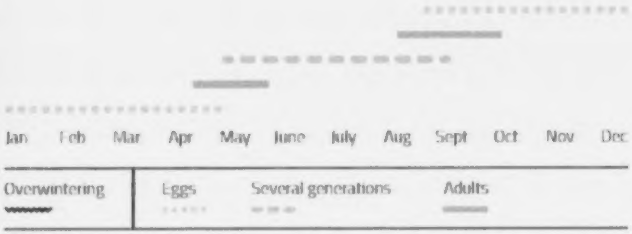
CHEMICAL: If the economic threshold is exceeded in peas, a single application of insecticide when 50% of plants have produced some young pods will protect the crop against yield loss and be cost-effective.

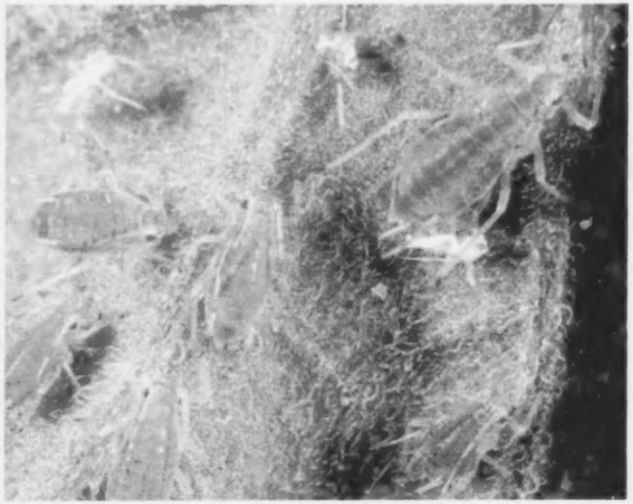


Potato aphid – adult, nymph
Christophe Quintin, Flickr

Aphid, potato

Macrosiphum euphorbiae (Thomas)





Potato aphid – adult, nymph
Joseph Berger, Bugwood.org

Hosts

Potato, flax, tomato, eggplant, pepper, turnip, corn, asparagus, clover, and rose. Weeds such as nightshade, ragweed, lambsquarters, jimsonweed, pigweed, and shepherd's-purse.

Identification

ADULTS: 2.5-3.5 mm long, pale yellow to light green, or pink, often with a darker dorsal stripe; long legs generally pale with tarsi and antenna with dark or dusky colored patches. The cornicles are long and extend to the end of the cauda.

MATURE NYMPHS: Similar appearance to adults but smaller.

Life Cycle

Overwinter as eggs on stems of roses on which 2-3 generations are produced asexually before winged females migrate to summer hosts (flax, potato, tomato) where several generations are produced over the summer. Winged forms are produced when colonies get overcrowded or the host plant quality declines. Later in the summer sexual forms are produced that mate and females return to winter hosts to lay eggs.

Feeding Damage

ADULTS AND NYMPHS: Potato-This aphid transmits potato leafroll, potato Y and A viruses. It feeds mostly on the upper leaves. Under severe attack, blossoms are shed and yield is reduced. New growth becomes stunted and curled. Heavily infested plants turn brown and die from the top down.

Flax-feeds on the stems, leaves, and developing bolls, causing reduced seed production and subsequent crop yields.

Similar Species

Green peach aphid (*Myzus persicae* (Sulzer), p. 61) is smaller and cornicles do not extend to the end of the cauda. This species feeds mainly on the lower leaves.

Monitoring/Scouting

For flax, examine a minimum of 25 plants at full bloom and 20 plants at early green boll randomly in the field by severing stems at the base, then lightly tapping the severed stems on a white surface, such as a tray, to dislodge the insects for counting. A sequential sampling plan is available for flax at www.gov.mb.ca/agriculture/crops/insects/aphids-on-flax.html.

Economic Threshold

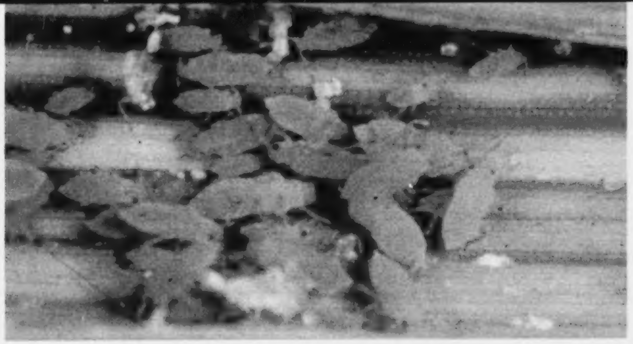
None for potatoes. For flax, 3 aphids/main stem at full bloom and 8 aphids/main stem at the green boll stage.

Management Options

BIOLOGICAL: Several species of predators (green lacewing (p. 139), snakefly (p. 140)) and parasitoids (*Aphidius matricariae* Haliday (p. 129), *A. ervi* Haliday (p. 129), *A. smithi* Sharma et Subba Rao (p. 129)) as well as pathogenic fungi attack this pest.

CULTURAL: Reducing nearby alternate summer hosts will reduce local population pressure.

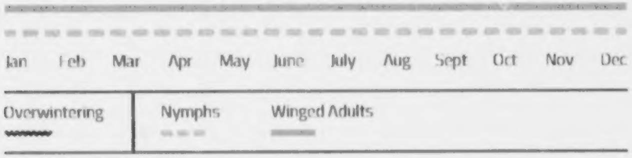
CHEMICAL: Control is rarely required in commercial potato crops. Seed potato crops must be protected from infection by viruses transmitted by this species. A single warranted application of a foliar insecticide at full bloom or the green boll stage of flax will provide protection until harvest.



Russian wheat aphid – adult, nymph
Frank Peairs, Colorado State University, Bugwood.org

Aphid, Russian wheat

Diuraphis noxia (Mordvilko)



Russian wheat aphid – damage
Frank Peairs, Colorado State University, Bugwood.org

Hosts

Wheat, barley, and many cool season grasses.

Identification

ADULTS: 1.6-2.1 mm long, spindle-shaped, and lime green in colour. Shortened antennae and reduced cornicles at the end of the abdomen are distinguishing characteristics. Adults also have a "double cauda" from the side view.

MATURE NYMPHS: Similar to adults but smaller.

Life Cycle

No male aphids have ever been found, thus no eggs are produced. Females reproduce asexually all year long and give birth to live young over 60–80 day life span (egg to adult, 10–14 days). Throughout the season, winged forms are produced which search out new hosts.

Feeding Damage

ADULTS AND NYMPHS: Suck sap from leaves causing characteristic white, purple or yellow streaks between leaf veins. Feeding can cause discolouration and prevent normal unrolling of leaves, plant and head stunting, and bleached heads with poorly formed grain.

Similar Species

The western wheat aphid, *D. tritici* (Gillette), is similar in appearance and also damages wheat, but is covered with wax and has a regular cauda.

Monitoring/Scouting

Prior to the soft dough stage, count the number of infested plants among 20 randomly selected plants at 5 sites across a zig-zag transect of the field. The % infested = total number of infested plants. Crops should be checked weekly up to soft dough stage.

Economic Threshold

WINTER CEREALS (After Oct. 1st): 15-20% seedlings infested.

SPRING CEREALS: 10-15% of seedlings, 15-20% of plants at boot stage.

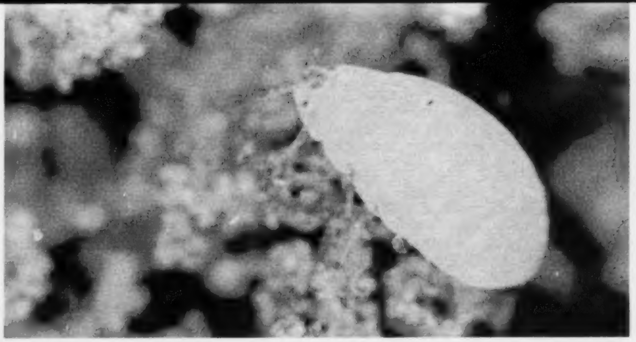
Management Options

BIOLOGICAL: Several species of parasitoids (*Aphidius matricariae* Haliday (p. 129), *A. smithi* Sharma et Subba Rao (p. 129)), predators (green lacewing (p. 139), snakefly (p. 140)) and fungal pathogens attack this aphid.

CULTURAL: Control volunteer host plants; plant spring grains early and fall grains late to reduce establishment of colonies.

CHEMICAL: Apply products least toxic to natural enemies if treatments are required.

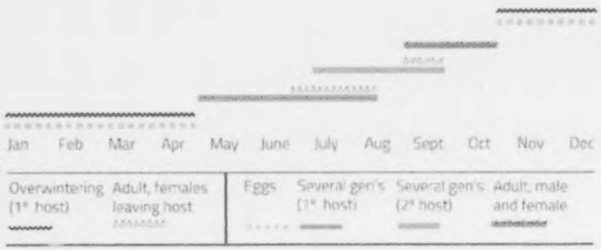
Russian wheat aphid – damage
International Maize and Wheat Improvement Centre (CIMMYT), Flickr



Sugar beet root aphid - adult
Erik J. Wenninger, University of Idaho

Aphid, sugar beet root

Pemphigus betae Doane



Hosts

Primary hosts are trees in the poplar (*Populus*) genus (e.g. balsam poplar, black poplar, and cottonwood); secondary hosts include sugar beet and the weeds lamb's-quarters, kochia and pigweed. Also reported infesting roots of red beets, Swiss chard, spinach, quinoa, and alfalfa.

Identification

ADULTS: Wingless adults are 1.9-2.4 mm long with oval-shaped, pale yellowish-white bodies coated with a fine white powder. Root-infesting forms have reduced appendages compared to leaf-infesting forms. Winged spring- and fall-adults are same size as wingless forms but have a black head and thorax and green abdomen. MATURE NYMPHS: Similar appearance to wingless adults but smaller.

Life Cycle

Overwinter as eggs in bark crevices of primary hosts. The eggs hatch in spring into wingless females ("stem mothers"). These give rise to colonies of winged females that develop within galls along the leaf midrib created by their feeding action. The winged females disperse to secondary hosts during early to mid-summer where they form wingless colonies on the host roots. The aphids secrete a waxy material that covers the individual colonies. After several generations, winged females are produced in late summer and early fall that then migrate back to winter (primary) hosts. Some root colonies may overwinter in the soil without producing fall migrants. The fall migrant females give birth to wingless males and females. After mating, females each lay a single white egg that overwinters under a white waxy secretion.

Feeding Damage

ADULTS AND NYMPHS: Feeding action can destroy rootlets and cause the tap root to become rubbery and flaccid, especially under drought conditions. Heavy infestations can kill sugar beet plants under extreme stress as well as reduce yields, sugar content and recoverable sugar. Leaves appear chlorotic and wilt easily under moisture stress. Heavily infested sugar beets are also pre-disposed to greater damage by early frost.

Similar Species

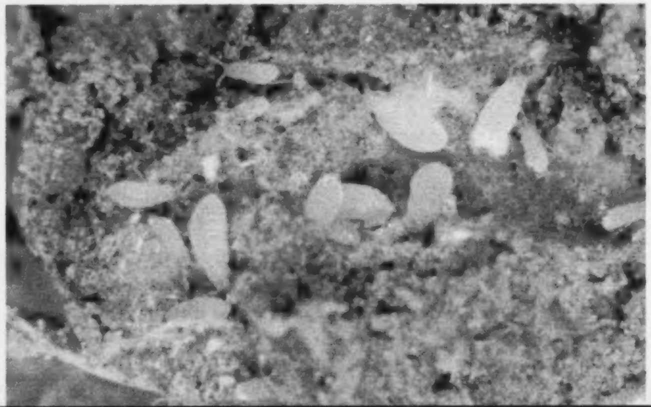
Co-occurring *Pemphigus* species on sugar beet roots can include *P. populitransversus* Riley and *P. populivenae* Fitch. The three species are difficult to distinguish without the aid of a microscope.

Monitoring/Scouting

No scouting methods have been developed. Dig up wilted plants and examine for root-infesting colonies to confirm presence. The presence of leaf midrib galls on primary hosts in the spring indicate the presence of this pest and a risk to sugar beet and other food crop hosts in the area.

Economic Threshold

None established.



Sugar beet root aphid - colony
Erik J. Wenninger, University of Idaho

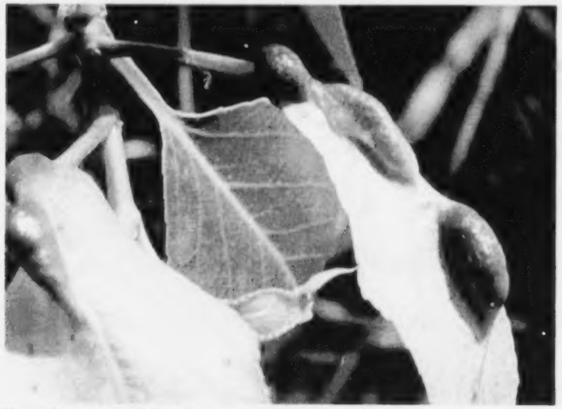
Management Options

BIOLOGICAL Leaf-gall colonies are attacked by an anthocorid bug (*Anthocoris antevolens* White), larvae of a hover fly (*Syrphus bigelowi* Curran (p. 132)), larvae of an aphid fly (*Leucopis pemphigae* Malloch), a ladybird beetle (*Scymus* spp. (p. 116), green lacewings (p. 139), snakeflies (p. 140) and parasitoids (*Aphidius smithi* Sharma et Subba Rao (p. 129)). A small frit fly (*Thaumatomyia glabra* (Meigen)) attacks root-infesting colonies and the pathogenic fungus, *Entomophthora aphidis* Hoffman occasionally destroys field populations.

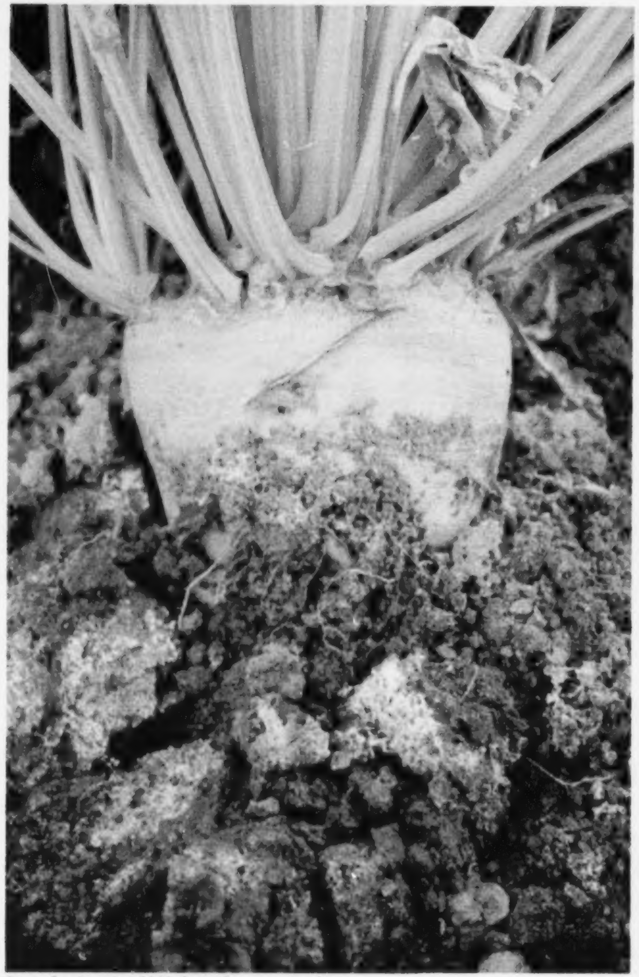
CULTURAL Grow sugar beet root aphid tolerant or resistant varieties. However, since sugar beet root aphid infestations are sporadic, it may make more economic sense over the long-term to choose varieties based on other agronomic considerations. More realistic strategies include:

- Plant sugar beets early and maintain adequate soil moisture and nutrients to encourage rapid and vigorous growth especially during drought conditions.
- Control weed hosts within and adjacent to crops.
- Do not replant fields to a host crop for a minimum of 3 years and maintain control of weed hosts every year.
- Clean all equipment thoroughly before moving from an infested to non-infested field.

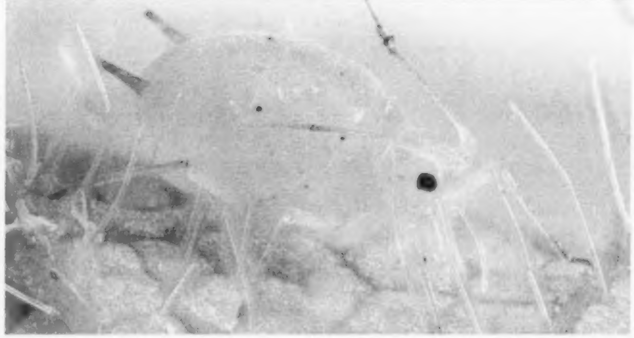
CHEMICAL None registered.



Sugar beet root aphid gall on eastern cottonwood (*Populus deltoides*)
Kevin Floate, AAFC

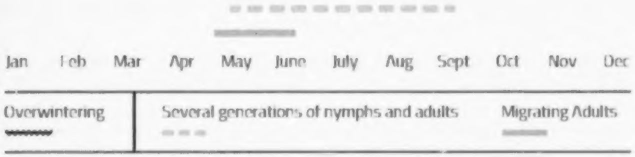


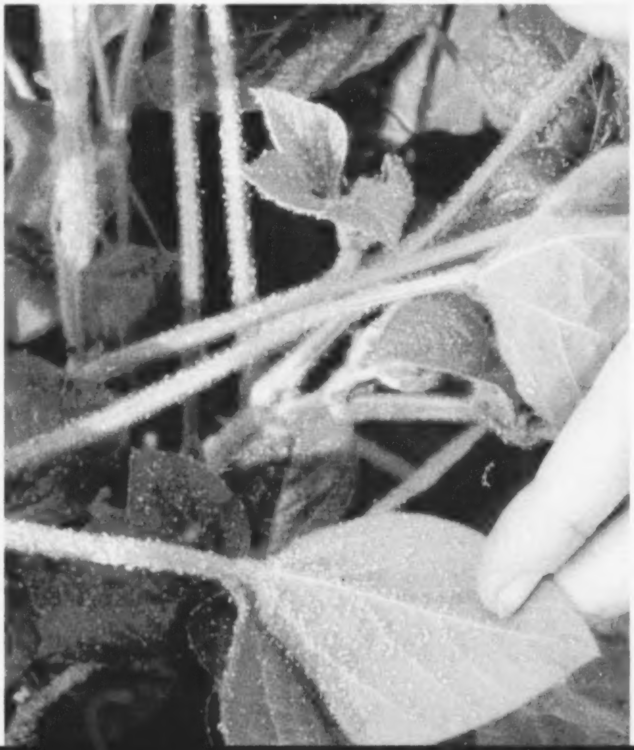
Sugar beet root aphid infestation on sugar beet
Erik J. Wenninger, University of Idaho



Soybean aphid – adult
Robert J. O'Neil, Purdue University (wiki)

Aphid, soybean
Aphis glycines (Matsumura)





Soybean aphid – infestation
Christina DiFonzo, Michigan State University,
Bugwood.org

Hosts

Soybeans.

Identification

ADULTS: Very small (1.5 mm long) pale yellow with distinctive black cornicles.

MATURE NYMPHS: Similar appearance to adults but smaller.

Life Cycle

Not known to overwinter in Canadian prairies. Blow in from U.S. where they overwintered as eggs on stems of buckthorn on which 3–4 generations are produced asexually before winged females migrate to soybeans where several generations are produced over the summer. Winged forms are produced when colonies get overcrowded and the host plant quality declines. Populations die off in the fall.

Feeding Damage

ADULTS AND NYMPHS: This aphid is a vector for soybean mosaic virus. It also produces sticky honey-dew on which black sooty mold develops. Feeding on the undersides of leaves, leaves may turn yellow, wilt, and/or curl. Infestations during the early reproductive stages can cause reduced pod formation, smaller seed size, and a reduction in seed quality.

Monitoring/Scouting

Estimate the numbers of aphids present on each of 6 randomly selected plants (mid-canopy leaves, stems, and pods) and the number of plants infested at 5 sites spaced at least 50 m (150 ft) apart across a zigzag transect of the field. Calculate the average number/plant. Repeat weekly up to growth stage R5 (beginning seed formation) to determine if numbers are increasing.

Economic Threshold

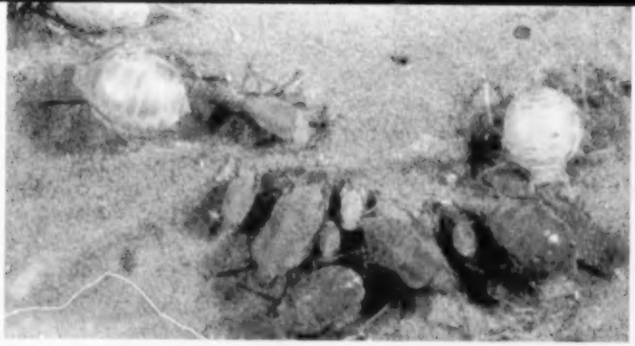
Average of 250/plant, the population is increasing, and the plants are in the R1 (beginning bloom) to R5 (beginning seed) growth stage.

Management Options

BIOLOGICAL: Several species of predators (green lacewing (p. 139), snakefly (p. 140)) and parasitoids (*Aphidius smithi* Sharma et Subba Rao (p. 129)) as well as pathogenic fungi are capable of controlling population levels of less than 200–250 aphids/plant.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

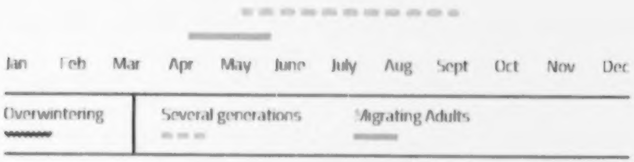
CHEMICAL: Insecticides are available to protect crops once the economic threshold is reached. Foliar treatments should be made within 7–10 days of reaching economic threshold to prevent economic injury.



Turnip aphid – adult; bloated, tan mummified aphid (wasp parasitoid); nymph
Alton N. Sparks, Jr., University of Georgia, Bugwood.org

Aphid, turnip

Lipaphis erysimi (Kaltenbach)



Hosts

Canola, turnips, other cruciferous plants

Identification

ADULTS: 1.4-2.4 mm long, yellowish to olive green body sometimes with waxy dusting, dark bars on abdomen; winged adults have dusky wing veins.

MATURE NYMPHS: Similar appearance to adults but smaller.

Life Cycle

Mated females migrate up from southern U.S. each spring and colonize host crops on which several generations (4-6 days/generation) are produced during the season before fall frosts kill them off. Winged females will move to alternate hosts to establish new colonies when colonies get overcrowded or food quality declines. Several generations per year.

Feeding Damage

ADULTS AND NYMPHS: Canola is most sensitive to aphid damage during bud formation through to late flowering. Dense colonies start on growing tips and move onto developing buds and flowers where the pests suck up plant fluids, resulting in reduced pod set, pod fill, and seed quality. Plants under moisture stress suffer greater damage.

Similar Species

Green peach aphid (p. 61) and cabbage aphid (*Brevicoryne brassicae* (Linnaeus)) can also be present. The latter species is gray-green in colour with a waxy covering and very short cornicles which are hard to see.

Monitoring/Scouting

When canola starts to form buds, examine 20 plants at each of 5 areas in the crop following a zigzag pattern beginning from one side. Record the number of infested tips.

Economic Threshold

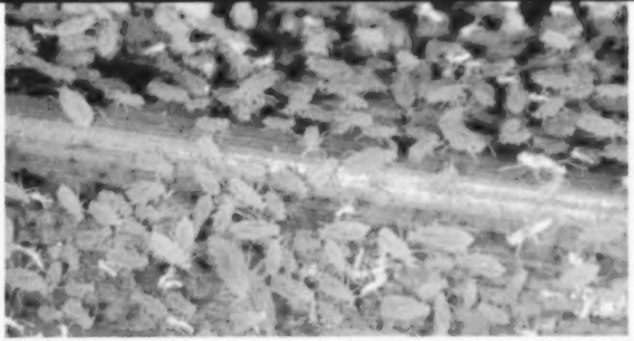
Control if densities exceed 25 aphids/10 cm shoot tip after flowering on 10-20% of examined stems.

Management Options

BIOLOGICAL: Several species of predators (green lacewing (p. 139), snakefly (p. 140)) and parasitoids (*Aphidius smithi* Sharma et Subba Rao (p. 129)) as well as pathogenic fungi are capable of controlling populations.

CULTURAL: Implement early control of weed hosts and volunteer canola where aphids can build up. Sow crops early to enable plants to begin flowering before aphid numbers peak.

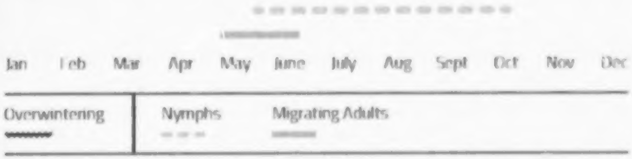
CHEMICAL: Insecticides are available for application as warranted.

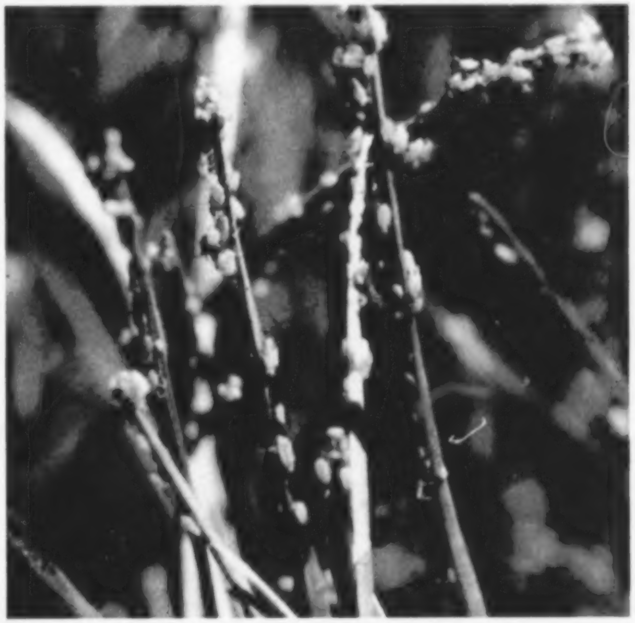


Greenbug – adult, nymph
Frank Peairs, Colorado State University,
Bugwood.org

Greenbug

Schizaphis graminum (Rondani)





Greenbug – infestation
Whitney Cranshaw, Colorado State
University, Bugwood.org

Hosts

Cereals, corn, and forage grasses.

Identification

ADULTS: 1-1.5 mm long, pale green pear-shaped aphids with a dark green stripe running down their backs and black-tipped pale green legs and cornicles.

MATURE NYMPHS: Similar appearance to adults but smaller; dark stripe down back appears in mature nymphs.

Life Cycle

Passes the winter on fall planted wheat and volunteer grains in Oklahoma and Texas. It migrates north in the spring, and passes through several generations during migration. Once arrived, it colonizes available host crops and passes through several asexual generations before dying off in the fall.

Feeding Damage

ADULTS AND NYMPHS: Toxic saliva released during feeding on the undersides of leaves causes discolouration, striping, wilting and brown spotting at feeding sites, stunted growth, retarded root growth, abnormal tillering, and improper filling of kernels. High populations can kill younger plants.

Similar Species

See descriptions of other species of grain aphids.

Monitoring/Scouting

Prior to the soft dough stage, count the number of aphids present on each of 20 randomly selected tillers at 5 sites across a zig-zag transect of the field. Calculate the average number/tiller.

Economic Threshold

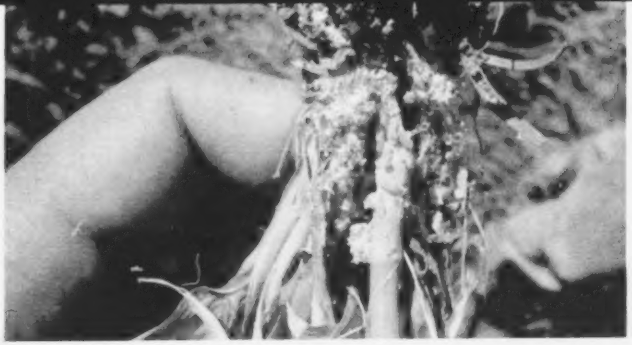
12-15 aphids/stem prior to the soft dough stage in small grain cereals. Rarely reaches levels that require control.

Management Options

BIOLOGICAL: Several species of parasitoids (*Aphidius ervi* Haliday (p. 129), *A. smithi* Sharma et Subba Rao (p. 129)), predators (green lacewing (p. 139), snakefly (p. 140)), and fungal pathogens attack this aphid.

CULTURAL: Earlier seeded crops may escape damaging colonization.

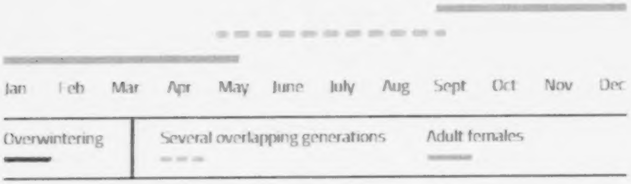
CHEMICAL: Apply products least toxic to natural enemies if treatments are required.



Haanchen barley mealybug – adult, damage
Juan Manuel Alvarez, University of Idaho, Bugwood.org

Mealybug, Haanchen barley

Trionymus haancheni McKenzie



Haanchen barley mealybug – damage
Juan Manuel Alvarez, University of Idaho, Bugwood.org

Hosts

Barley primary host; wheat less preferred.

Identification

ADULTS: Females have 5 mm long, elongate-oval, segmented, and a slender pink bodies covered in thin, wispy filaments of wax along the edges of the body and at the posterior end of the body. They have well-developed slender legs. Only males have wings and are rarely seen. All other life stages move short distances by crawling from plant to plant or over longer distances on wind currents and as accidental hitch-hikers on infested plants or soil on machinery.

MATURE NYMPHS: Also known as crawlers; resemble adults, yellowish coloured, slow moving.

Life Cycle

Females overwinter in soil protected by crop debris. In the spring females crawl or are carried to new crops. First signs of mealybug presence are cottony masses enclosing clusters of pink-red eggs under leaf sheaths.

Feeding Damage

ADULTS AND NYMPHS: Pierce plant tissue to feed on fluids at protected sites on the plant—on upper portions of the root system, in the crown of the plant, under leaf sheaths, or near the base of tillers. Feeding by both females and nymphs causes extensive yellowing, browning of the foliage, and reduced vigor and root growth due to toxins in the saliva. Severe infestations can kill plants. They also secrete large amounts of honeydew, making the plants sticky which can plug up combine headers. Black sooty mold also develops on the honeydew deposits. Damage is acerbated by dry conditions.

Similar Species

A related species, the Utah grass mealy bug, *Trionymus utahensis* (Cockerell), is present in B.C. where it feeds on wild rye and crested wheatgrass.

Monitoring/Scouting

None developed.

Economic Threshold

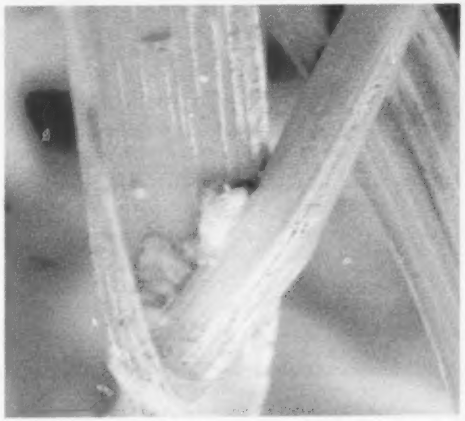
None established.

Management Options

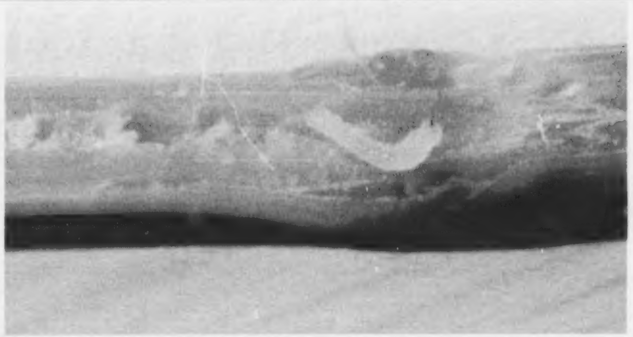
BIOLOGICAL: Specific natural enemies are not known that can regulate pest populations. Green lacewing (p. 139) may prey on mealybugs.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL: None registered in Canada.

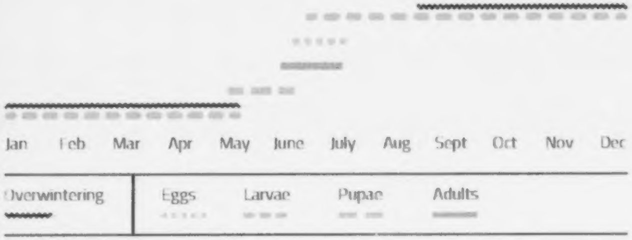


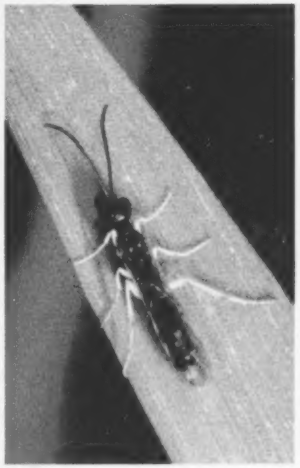
Haanchen barley mealybug – eggs
Juan Manuel Alvarez, University of Idaho, Bugwood.org



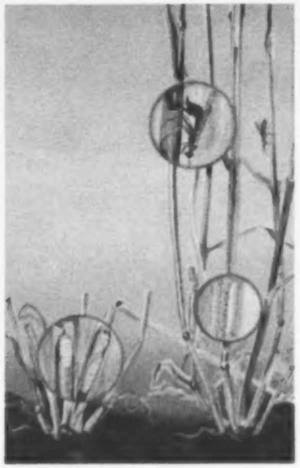
Wheat stem sawfly – larva
Mike Dolinski, MikeDolinski@hotmail.com

Sawfly, wheat stem
Cephus cinctus (Norton)





Wheat stem sawfly – adult
Alberta Agriculture and Rural Development



**Wheat stem sawfly –
egg, larva, adult, damage**
Art Cushman, USDA Systematics Entomology Laboratory, Bugwood.org

Hosts

Spring and durum wheat are primary hosts; winter wheat, rye, grain corn, barley, and some native grasses can support sawfly development. It cannot develop on oats (toxic to the pest). Host stages prior to stem elongation are not attractive for egg laying.

Identification

ADULTS: 8–13 mm long, shiny black wasp-like with yellow legs; at rest on plant stems they point their heads downwards. Females have an egg-laying appendage (ovipositor) extending from their abdomen.

MATURE LARVAE: 13 mm slender whitish worm-like with brown head.

Life Cycle

Overwinters as mature larvae in base of stems in infested fields from which females emerge and fly to nearby wheat crops. Up to 50 eggs/female are laid singly on stems. Adults live about 10 days and do not feed.

Feeding Damage

ADULTS: None.

MATURE LARVAE: Larvae feed on the pith of host plant stems which can reduce crop yield and quality. When plants mature, larvae move to the bottom of the stem where they cut a "V" notch in the stem wall just above ground level. The notching makes the stems susceptible to breaking and falling to the ground where they are unharvestable. Infestations are generally greater around crop margins.

Similar Species

None.

Monitoring/Scouting

Count the proportion of stems cut by sawfly in a 1 m row of crop at 5 to 10 spots along crop margins to determine local risk for next year. Use a sweep net to sample for adult sawflies in late June into July. The need to swath can be determined by estimating the proportion of stems containing larvae. Split 50–100 stems at each of 10 locations including the edge and inside the field. Presence of parasitoid (another larva attached to the sawfly larva) reduces the need to swath. Risk maps are available online for producers to consult to make informed cropping decisions to minimize crop losses.

Economic Threshold

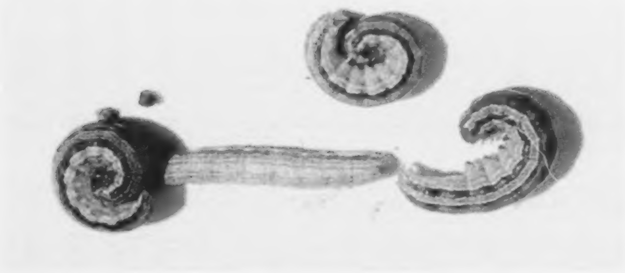
Control may be required if 10-15% of crop in previous year is cut by sawfly.

Management Options

BIOLOGICAL: Nine species of parasitic wasps attack this pest. The parasitic wasp *Bracon cephi* (Gahan) is the primary natural enemy. *B. lissogaster* Muesebeck (p. 130) is a second major parasitoid which has recently moved into S. Alberta from the U.S..

CULTURAL: Do not plant successive wheat or other hosts crops; rotate with solid-stemmed wheat varieties. When possible, earlier swathing can reduce losses. Shallow tillage in the fall can greatly increase larval mortality in situations where there is no or little risk of soil erosion. Additional cultural practices include seeding at rates no greater than 300 seeds/m^2, applying 30 to 60 kg N/ ha, and harvest cutting heights of at least 15 cm.

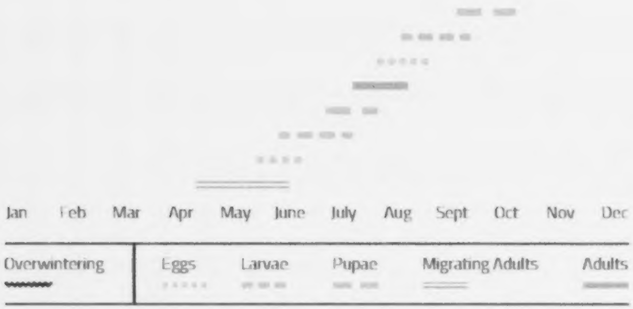
CHEMICAL: No control products have proven effective.

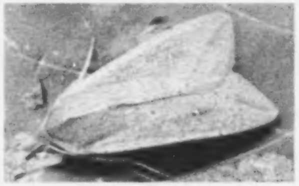


Armyworm – caterpillar
AAFC

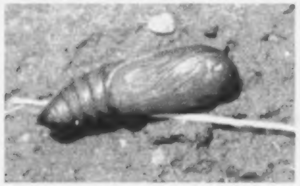
Armyworm

Pseudaletia (Mythimna) unipuncta (Haworth)

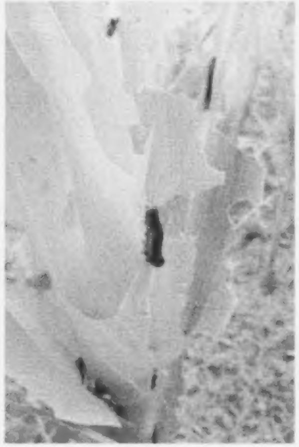




Armyworm – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development



Armyworm – pupa
John Gavloski, Manitoba Agriculture, Food and Rural Development



Armyworm – caterpillar, damage
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

Major hosts include native grasses, oats, wheat, fall rye, corn, barley, and forage grasses; secondary hosts include alfalfa, cabbage, and turnips.

Identification

ADULTS: 20 mm long, pale coloured body with pale brown forewings, each with a single small white spot. Wing span is 41-48 mm.

MATURE LARVAE: 38-50 mm long, fleshy caterpillars, usually greenish-black with two alternating dark and orange stripes along each side plus a faint white line down the back. Head capsule has honey-comb like markings.

Life Cycle

Moths are blown up from the southern U.S. each spring; females lay white eggs in batches of about 100 at the bases of host plants. Mature larvae pupate in soil cells 2–4 cm under the surface. Usually two larval generations per year before populations die off in the fall.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: All instars feed on leaf margins and crown tissue of host plants at night, hiding near the base of plants during the day. Larvae gradually move up the plants to feed on the panicles and flowers, stripping off the awns and kernels. Larvae will march to nearby crops when current food plants mature or are consumed. First generation larvae cause the greatest damage, however later maturing crops can be attacked by the second larval generation.

Similar Species

Fall armyworm (p. 76) and army cutworm (p. 86) larvae as well as redbacked (p. 93), pale western (p. 92) and dingy cutworms (p. 90).

Monitoring/Scouting

Use light or pheromone traps to detect the arrival of immigrating adults. To assess prevalence of larvae in cereals and grasses, check at least five areas, preferably where birds are present and grassy or lodged areas; or leaves showing feeding damage. If scouting during the day, remove ground debris from a 1 m^2 area and count the exposed larvae. If scouting at night, beat the plants in a 1 m^2 area to dislodge any larvae and, using a flashlight, count the number of larvae on the soil.

Economic Threshold

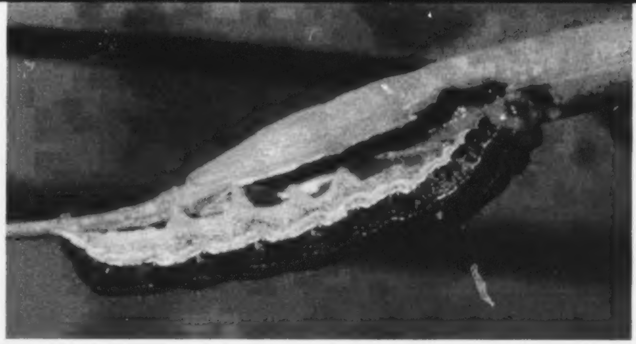
Cereals and grasses—10 larvae/m^2.

Management Options

BIOLOGICAL: Grackles and red-winged black birds prey on larvae in cereals; generalist predatory insects and parasitoids (*Cotesia marginiventris* (Cresson) (p. 130), *Trichogramma minitum* Riley (p. 138)) attack larvae and/or eggs.

CULTURAL: Destroy grass weeds before arrival of adults to reduce egg-laying and risk of subsequent infestations.

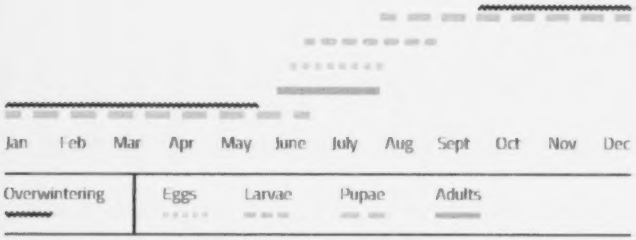
CHEMICAL: Only spray areas where armyworm larvae exceed the economic threshold. Spray at night when larvae are actively feeding. Do not spray once larvae mature and start to pupate, or the crop is ripening.



Bertha armyworm – caterpillar
Mike Dolinski, MikeDolinski@hotmail.com

Armyworm, bertha

Mamestra configurata (Walker)



Hosts

Canola, mustard, alfalfa, lamb's-quarters and related plants; occasionally attack peas, flax, potato, and other plants.

Identification

ADULTS: 20 mm long, greyish body with 40 mm wing span; characteristic wing markings on the forewing include a prominent, white, kidney-shaped marking near the midpoint, and a conspicuous white and olive-colored, irregular transverse marking near the tip.

MATURE LARVAE: 40 mm long, velvety black (occasionally light green or light brown) caterpillars with a light brown head and a broad, yellowish-orange stripe along each side and three narrow, broken white lines down their backs.

Life Cycle

Overwinter as pupae 5–16 cm below soil surface; round ridged eggs are laid in clusters on underside of leaves; females are attracted to blooming host crops.

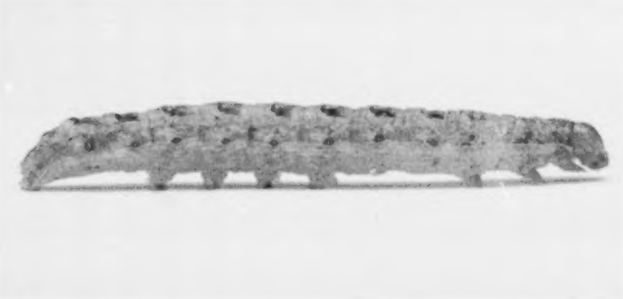
Feeding Damage

ADULTS: Feed on nectar from flowers.

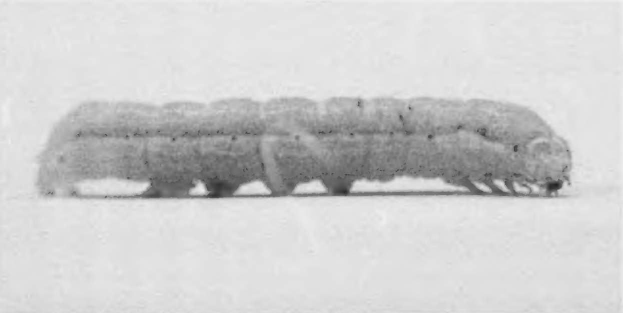
MATURE LARVAE: In canola, larvae move from leaves to pods where they either "debark" the pods, chew into them to eat the seeds, or totally consume pods. Severely stripped pods may prematurely shatter. Crops can take on a frosted appearance. In flax, they cut flowers and developing bolls.

Similar Species

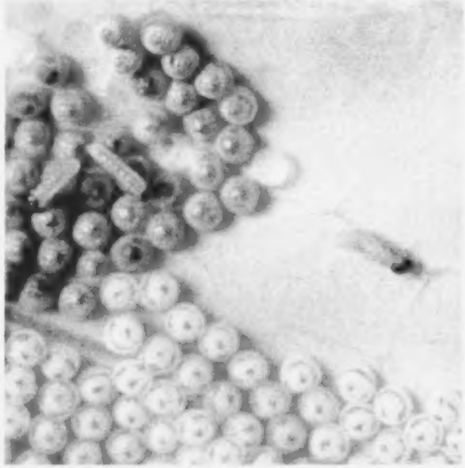
Clover cutworm larvae (p. 88) look similar but the lateral band is yellowish-pink, and there are more greenish or brown along with black larvae than among bertha armyworm infestations.



Bertha armyworm – caterpillar (brown form)
Alberta Agriculture and Rural Development



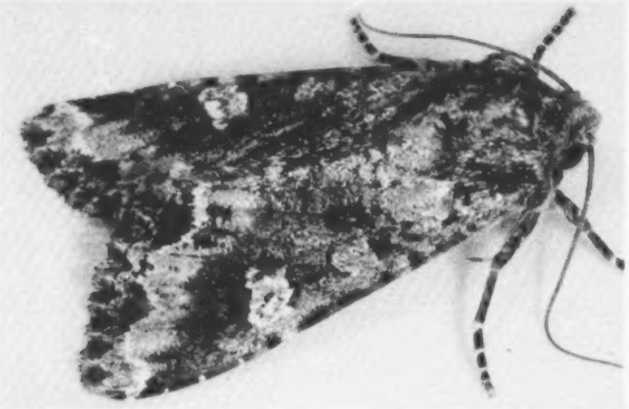
Bertha armyworm – caterpillar (green form)
Alberta Agriculture and Rural Development



Bertha armyworm – eggs
AAFC

Bertha armyworm – damage
Mike Dolinski, MikeDolinski@hotmail.com

Bertha armyworm – damage
AAFC



Bertha armyworm – adult
Alberta Agriculture and Rural Development

Monitoring/Scouting

Provincial forecast maps (based on male moths caught in pheromone-baited traps), are posted on-line indicating the annual risk of an infestation. When canola crop is in the early pod stage (stages 5.1-5.2), count the number of larvae in a 0.25 m^2 area in 10-15 different locations spaced at least 50 m apart following a zigzag pattern. Shake the plants to dislodge the larvae and then remove leaf debris and soil clumps to expose the larvae for counting. Calculate the number of larvae/m^2.

Economic Threshold

Tables are available on provincial government web sites that show the economic thresholds for canola at different crop values and costs of chemical control.

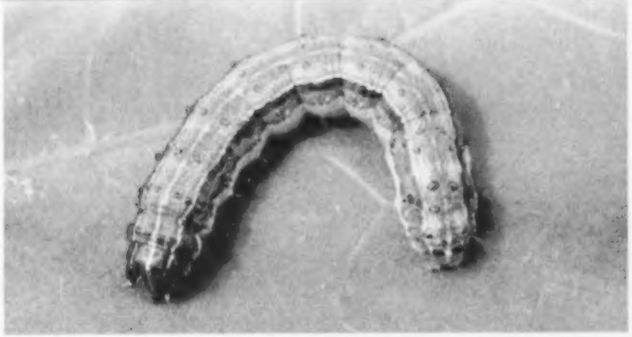
Management Options

BIOLOGICAL: Several diseases and natural enemies attack eggs and larvae, including a nuclear polyhedrosis virus, a brachonid wasp (*Microplitis mediator* (Haliday) (p. 130)) an ichneumonid wasp (*Banchus flavescens* Cresson (p. 135)), a tachinid fly (*Athrycia cinerea* (Coquillett) (p. 123)), and egg parasitoids (*Trichogramma inyoense* Riley (p. 138), *T. minitum Riley* (p. 138)).

CULTURAL: Recommended practices include crop rotation with non-crops, effective control of weed hosts, early swathing (minimize larval feeding) and fall cultivation (expose pupae). Do not kill nearby infested weed hosts while the crop is susceptible to feeding damage.

CHEMICAL: Several products are available for application as dictated by scouting. Apply in mid-morning or early evening when more larvae are feeding at the top of the crop canopy.

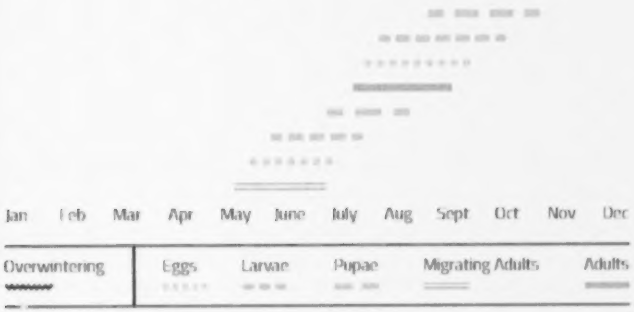
Bertha armyworm – damage
Alberta Agriculture and Rural Development

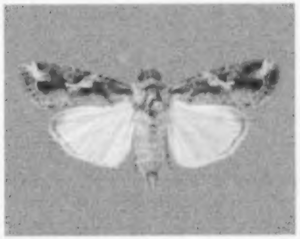


Fall armyworm – caterpillar
Russ Ottens, University of Georgia, Bugwood.org

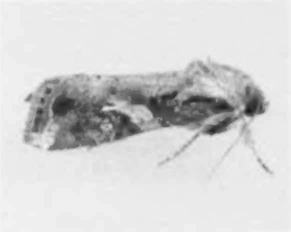
Armyworm, fall

Spodoptera frugiperda (J.E. Smith)

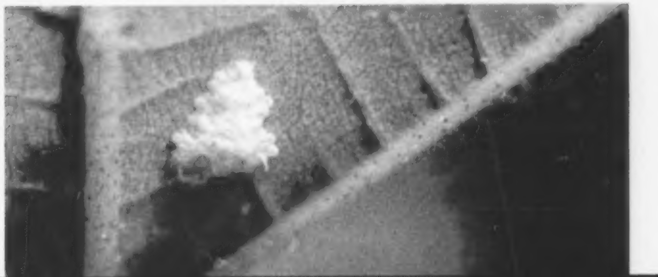




Fall armyworm – adult
Lyle Buss, University of Florida, Bugwood.org



Fall armyworm – adult
Mark Dreiling, Bugwood.org



Fall armyworm – eggs
David Jones, University of Georgia, Bugwood.org

Hosts

Corn is a major host, followed by cereals, and native and forage grasses.

Identification

ADULTS Forewings mottled dark gray with light and dark patches and a noticeable white patch near the tip; 35-40 mm wingspan.

MATURE LARVAE 38-50 mm long, dull tan, greenish to gray caterpillar with stripes running down the length of the body. Head is dark brown with a distinct white inverted "Y" marking.

Life Cycle

Moths are blown in from the southern U.S. each spring. Females lay eggs on grasses, emerging host crops, and later in lodged cereal crops. Pupation occurs in the soil. Populations die off in the fall.

Feeding Damage

ADULTS Feed on nectar of flowers.

LARVAE The most frequent damage by the fall armyworm is to the whorl of late pre-tassel corn. Several larvae may feed throughout the tightly coiled blades resulting in numerous ragged holes when the blades unfurl which may prevent plants from producing normal ears or seed heads. As with the corn earworm, wet, tan excrement can be found lodged in the remaining blades and blade axils. Feeding damage to the growing buds can significantly reduce yields. Older larvae may bore into stalks.

Similar Species

Armyworm (p. 73), corn earworm (p. 95).

Monitoring/Scouting

Use light or pheromone traps to detect arrival of moths in the spring. See armyworm (p. 73) for scouting cereals and grasses. In sweet corn, examine ten plants at a minimum of 10 sites per field prior to tassel emergence and weekly through the whirl stage (Ontario).

Economic Threshold

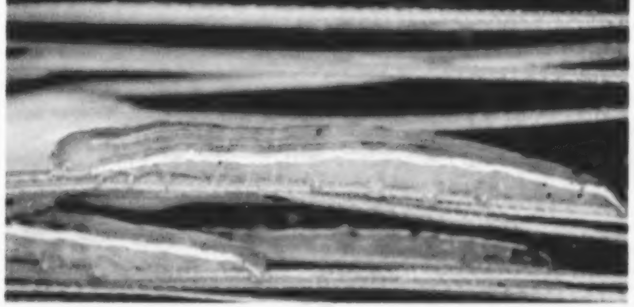
None established.

Management Options

BIOLOGICAL Eggs and larvae are attacked by generalist insect predators, parasitoids (*Trichogramma minitum* Riley (p. 138)) and spiders (pp. 111-114).

CULTURAL Some transgenic hybrid varieties are resistant to damage and could be considered for late-planted corn.

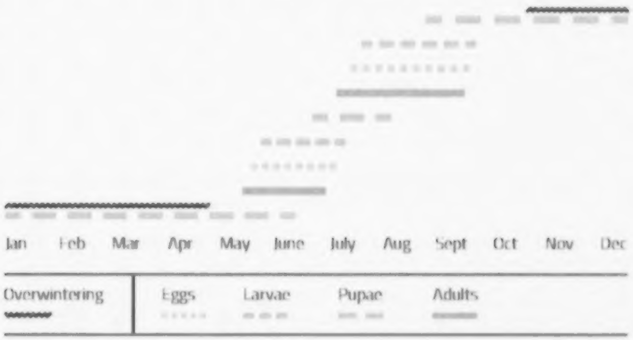
CHEMICAL Consult provincial recommendations for selection and timing of applications if required.

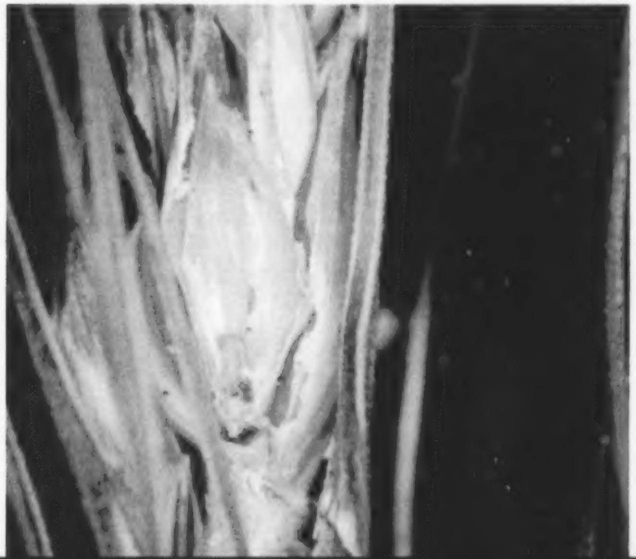


Wheat head armyworm – caterpillar
Mike Dolinski, MikeDolinski@hotmail.com

Armyworm, wheat head

Faronta diffusa (Walker)





Wheat head armyworm – damage
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

Wheat, rye, oats, barley, wild oats, and native and forage grasses (timothy preferred).

Identification

ADULTS Forewings yellowish-brown with a chocolate-coloured stripe down the length of each; 30–38 mm wing span.

MATURE LARVAE Up to 25 mm long, tan or green caterpillars with lateral white, gray, green, or brown stripes that appear to taper towards the end. The head is pale brown.

Life Cycle

Overwinter as pupae in earthen cells. Females lay eggs on available host plants, preferring wheat and some grasses. Summer adults have an extended flight period, and lay eggs on warm-season grasses. Two generations per year.

Feeding Damage

ADULTS Feed on nectar of flowers.

LARVAE The first larval generation is the most harmful to wheat. Feeds on above-ground plant parts during the night, causing some defoliation; may also feed on maturing grain heads and chew directly into the developing kernels. Damaged kernels appear hollowed out and resemble those damaged by stored grain pests.

Similar Species

No similar larvae, however armyworm larvae (p. 73) may be present near or on the heads.

Monitoring/Scouting

When damage to wheat heads appears, use a sweep net at night to scout for feeding larvae; during the day, examine the top 3–6 cm of soil around the plants for the larvae.

Economic Threshold

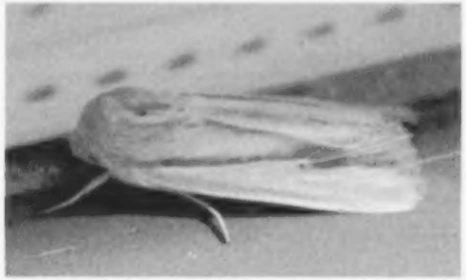
None established.

Management Options

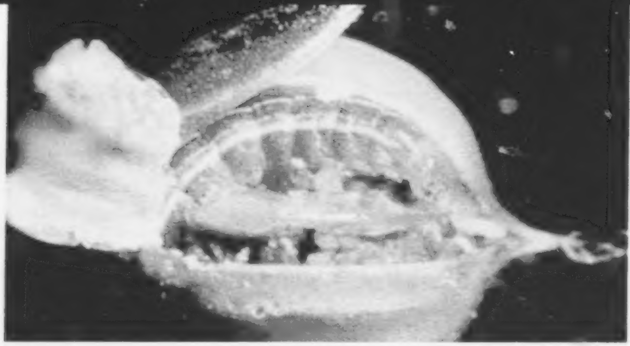
BIOLOGICAL Attacked by several species of parasitoids, predatory insects, and spiders (pp. 111–114).

CULTURAL Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL Infestations are very sporadic and rarely reach levels requiring control.



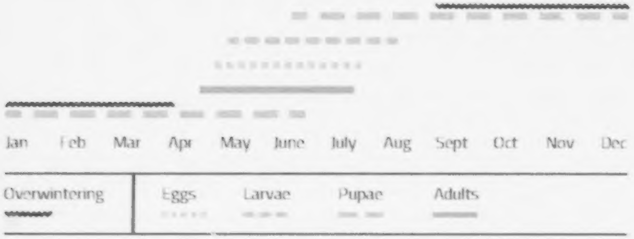
Wheat head armyworm – adult
Whitney Cranshaw, Colorado State University, Bugwood.org



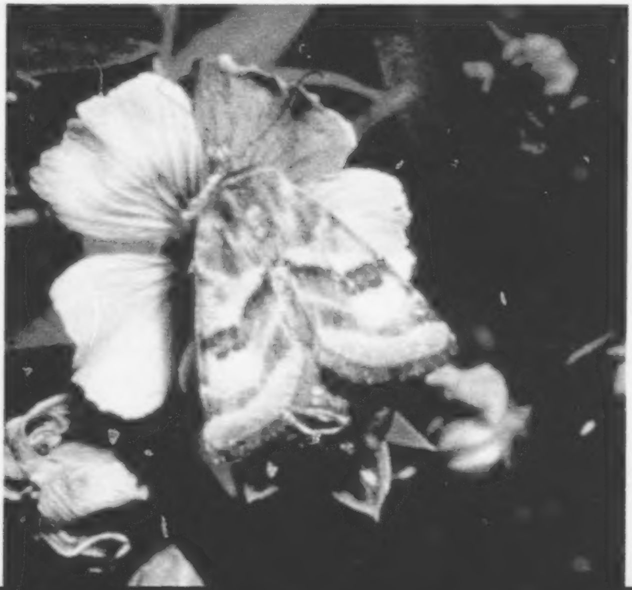
Flax bollworm – caterpillar, damage
AAFC

Bollworm, flax

Heliothis ononis Denis & Schiffermüller



Flax bollworm – adult
AAFC



Hosts

Flax is only cultivated host crop; also feeds on a number of native plants in grasslands, meadows, roadsides, and wooded clearings.

Identification

ADULTS Small moth with 24–26 mm wingspan. Forewings are reddish brown at base with dark brown median band incorporating the large black kidney-shaped spot.

MATURE LARVAE Green with distinctive white lines along the back and sides.

Life Cycle

Overwinter as pupae in the soil. Females lay eggs in open flowers.

Feeding Damage

ADULTS Feed on the nectar of flowers.

LARVAE Young larvae eat the developing seed within flax bolls and leave to feed in other bolls as they mature.

Similar Species

None.

Monitoring/Scouting

None.

Economic Threshold

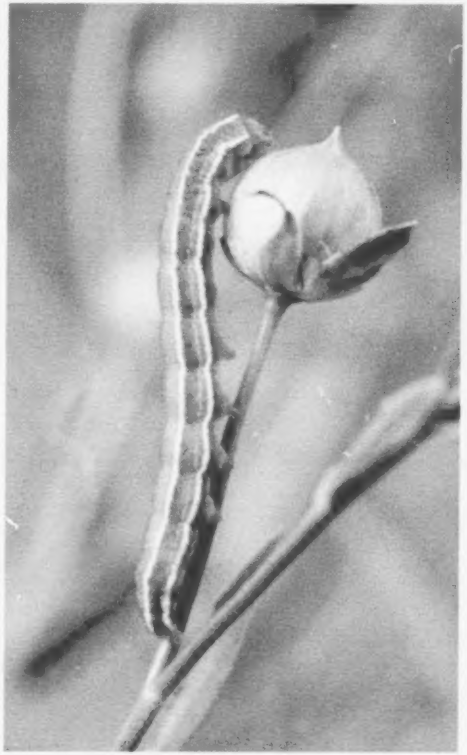
None required as economic infestations are rare and isolated.

Management Options

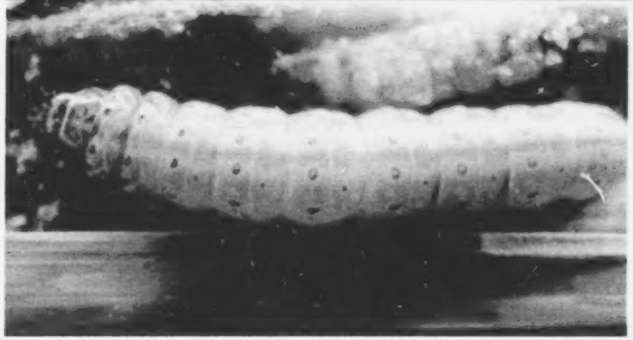
BIOLOGICAL *Trichomalopsis sarcophagae* (Gahan) (Pteromalidae) (p. 137) is the major larval parasitoid in grasslands and keeps populations from threatening flax crops.

CULTURAL Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL None registered in Canada.

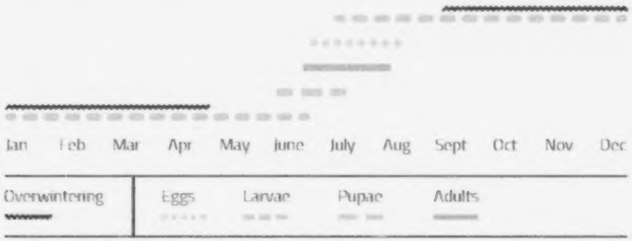


Flax bollworm – caterpillar
AAFC



European corn borer – caterpillar, damage
John Gavloski, Manitoba Agriculture, Food and Rural Development

Borer, European corn
Ostrinia nubilalis (Hübner)



Hosts

Sweet, grain and silage corn, tomatoes, potatoes, beans, sugar beets, and many species of large stemmed flowers and weeds.

Identification

ADULTS: 12 mm long, moth with a wingspan of 25 mm; buff-coloured forewings with brown markings. Male wings are darker than those of females.

MATURE LARVAE: 25 mm long, flesh-coloured caterpillars with black spots on each segment.

Life Cycle

Overwinters as mature larvae in corn stalks, cobs, and under plant debris on the soil surface. Females lay overlapping eggs in whitish-yellow clusters on leaves, usually on the underside. One generation per year.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: Young larvae feed on leaves and cause shot hole and window pane damage; older larvae burrow into and feed within the stalks and ear shanks, disrupting distribution of nutrients and causing stalk breakage and smaller cobs. They also fed on the silks, kernels, and cobs, often causing the latter to drop prematurely.

Similar Species

None.

Monitoring/Scouting

Pheromone-baited traps can determine the onset and duration of flight, and for initiating surveys of egg masses and shot hole damage. Beginning in early-July, or based on trap catches, at 5 locations examine 10 plants for young larvae and egg masses.

Economic Threshold

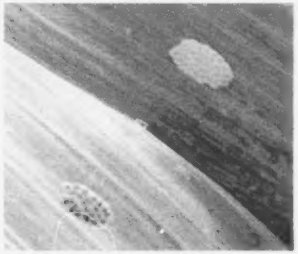
Tables are available that show economic thresholds for grain corn at different crop values and chemical control costs.

Management Options

BIOLOGICAL: Natural enemies include the egg parasitoids *Trichogramma* spp. (p. 138), the braconid larval parasitoid *Macrocentrus cingulum* Brischke (p. 130), the fungus *Beauveria bassiana*, and the protozoa *Nosema pyrausta*, as well as generalist insect predators.

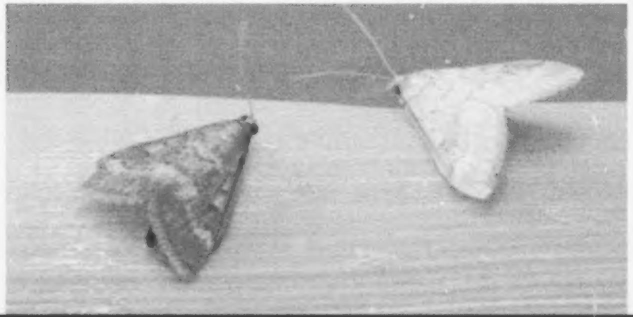
CULTURAL: Crop rotation, fall or spring deep plowing of infested stubble to expose larvae and pupae to predation and freezing temperatures; control of weed hosts within and adjacent to fields will reduce egg laying sites. Planting transgenic *Bt* corn is also an option following prescribed resistance management practices.

CHEMICAL: Apply only if economic thresholds are reached. Once larvae have entered the stalks, chemical control is no longer effective.



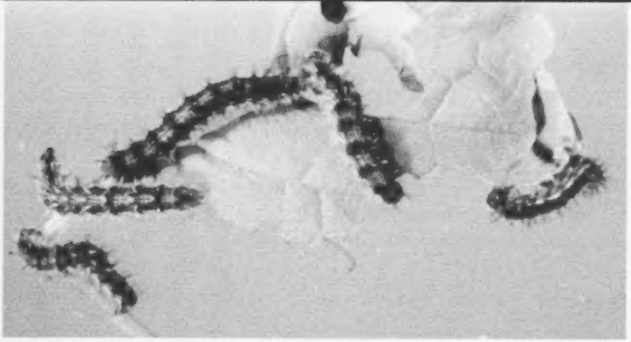
European corn borer – eggs
John Gavloski, Manitoba Agriculture, Food and Rural Development

European corn borer – caterpillar, damage
Manusz Sobieski, Bugwood.org



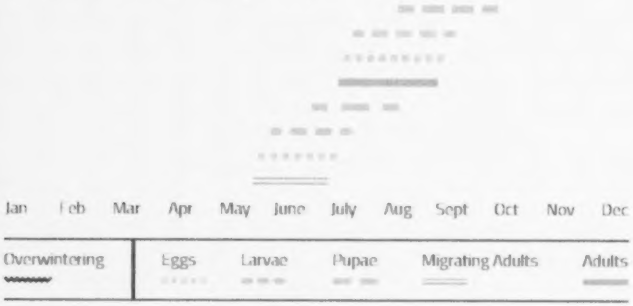
European corn borer – adult
Adam Sisson, Iowa State University, Bugwood.org

European corn borer – caterpillar, damage
Manusz Sobieski, Bugwood.org



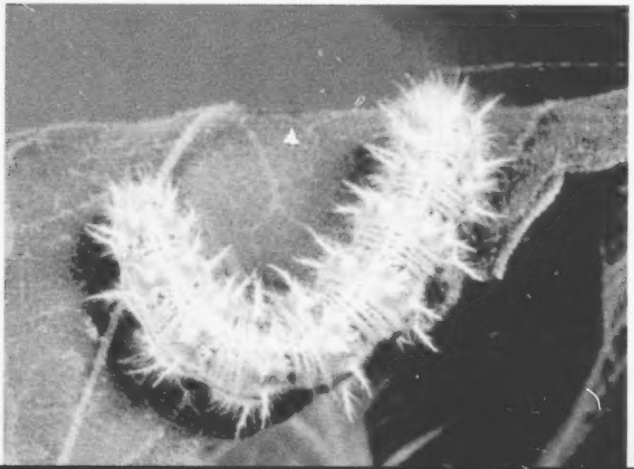
Butterfly, painted lady

Vanessa cardui (Linnaeus)
(a.k.a. thistle caterpillar)



Painted lady – adult
William M. Ciesla,
Forest Health Management
International, Bugwood.org

Painted lady – caterpillar
AAFC



Painted lady – caterpillar
AAFC

Hosts

Canada thistle, sunflowers, canola, mustard, borage, soybeans, burdocks, knapweeds, wormwood, and many other hosts.

Identification

ADULTS: Medium-sized butterflies with pointed wings spanning 42-66 mm and is salmon-pink in colour, with complicated dark markings on the upper surface.

MATURE LARVAE: 40-45 mm long, yellowish green or purple mottled with black and a broad white stripe along each side. There are many yellow spines and the head is black.

Life Cycle

Adults are occasionally blown up from southern U.S in vast numbers that settle on weed hosts. The pupa/chrysalis is suspended by silk threads from plants. At least one larval generation per year; two if summer temperatures favourable. Populations die off in the fall.

Feeding Damage

ADULTS: Feed on nectar of flowers.

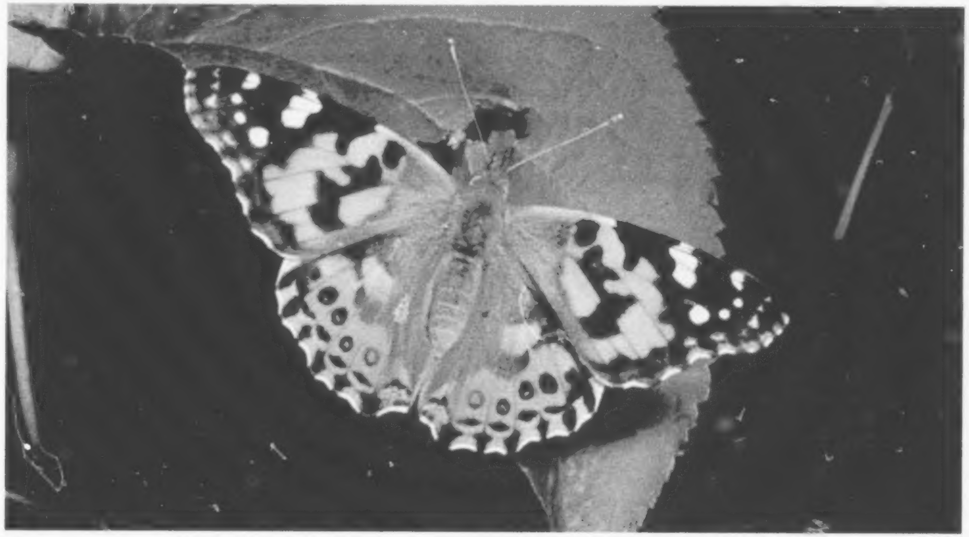
LARVAE: Larvae feed together in leaf-nests created near the terminals of host plants.

Similar Species

The Painted Lady is similar to the American Lady (*V. virginiensis* (Drury)) in the east and the West Coast Lady (*V. annabella* (Field)) in the west. The more pointed wings, pinkish-orange colour, and the lack of blue centres in the eyespots on the hind wing upperside differentiate the Painted Lady.

Monitoring/Scouting

If the butterflies are very abundant in a canola, mustard, or sunflower crop, inspect the crop weekly until caterpillars are noticed feeding on the plants. In sunflowers, examine ten randomly selected plants from 10 areas of the field and record the number of damaged plants. Calculate the percentage of infested plants.



Economic Threshold

SUNFLOWERS: As a nominal threshold, control may be warranted if 25% defoliation and most of the larvae are less than 3 cm long. If the majority of larvae are fully grown, most of the feeding damage will have already occurred.

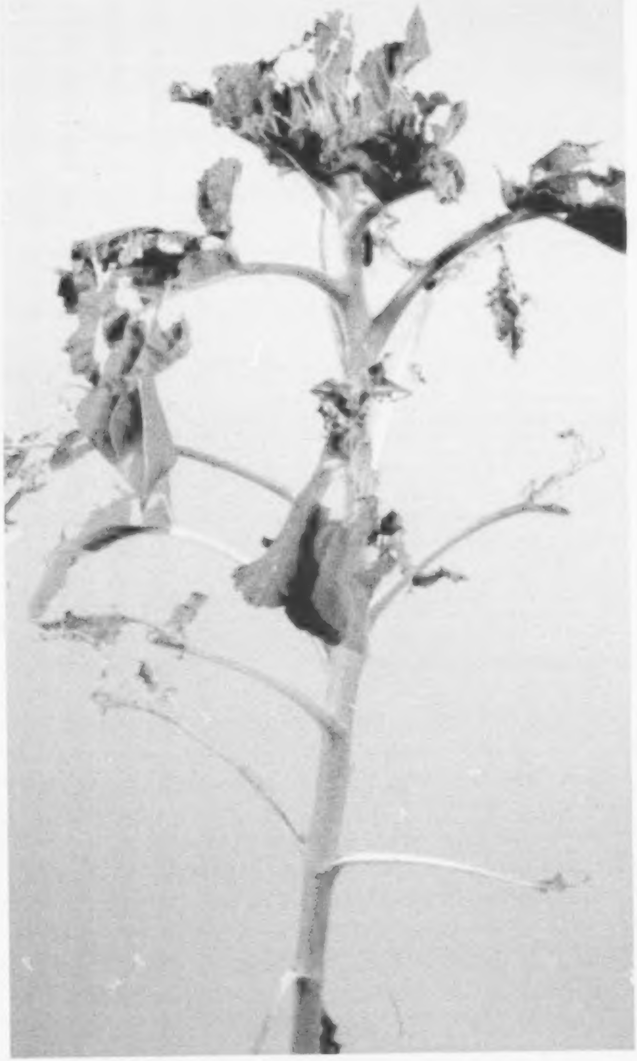
SOYBEANS: The following generalized defoliation thresholds, which can apply to several defoliating caterpillars, can be used: vegetative stage—50%, bloom—40%, bloom-pod fill—20%, and pod fill-harvest—35%.

Management Options

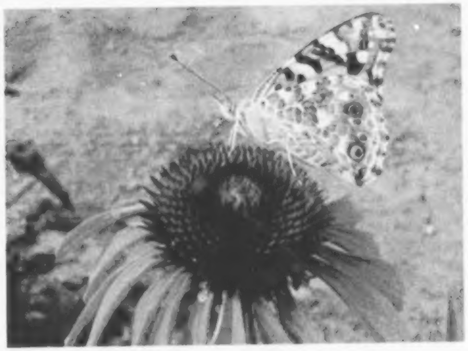
BIOLOGICAL: Usually heavily parasitized and subject to bacterial disease. Some birds, rodents, dragonflies, wasps, and spiders attack the larvae and adults.

CULTURAL: Control weed hosts, especially Canada thistle, in and around fields.

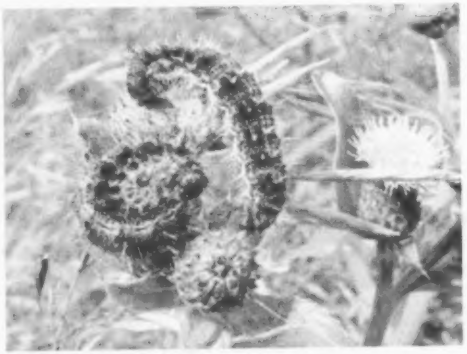
CHEMICAL: None registered in Canada.



Painted lady – damage
AAFC

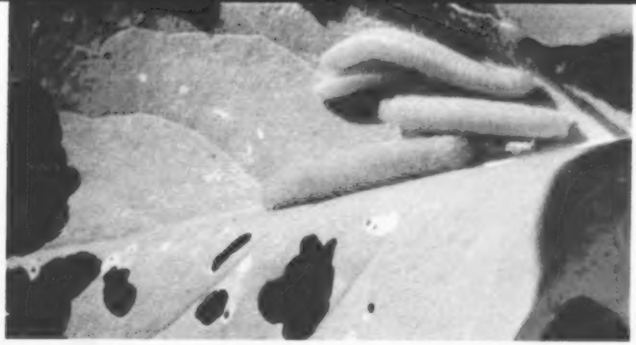


Painted lady – adult
Tyler Wist, AAFC



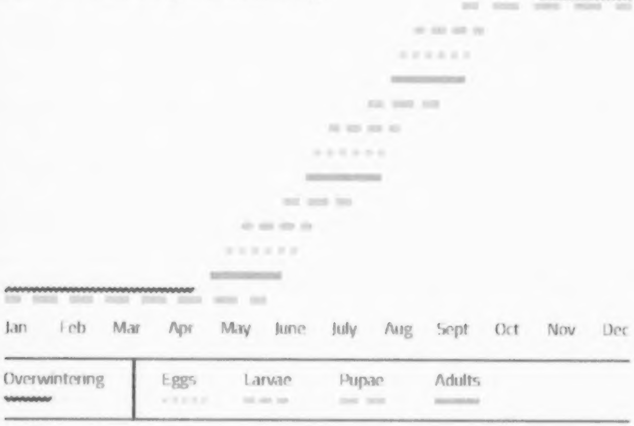
Painted lady – caterpillar
Tyler Wist, AAFC

Painted lady – cocoon
Mike Dolinski, MikeDolinski@hotmail.com

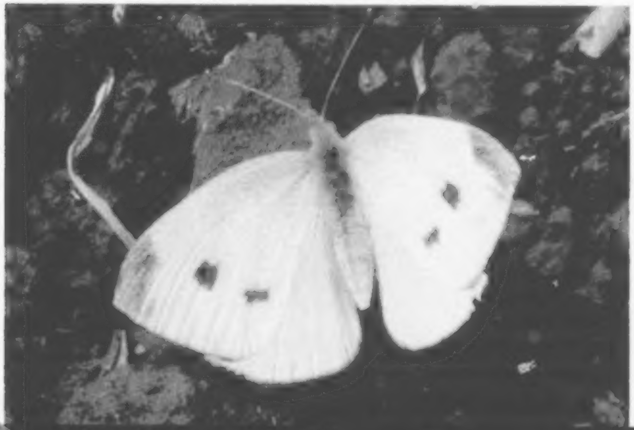


Imported cabbage worm – caterpillar
Mike Dolinski, MikeDolinski@hotmail.com

Cabbageworm, imported
Pieris rapae (Linnaeus)
(a.k.a. cabbage butterfly)



Imported cabbage worm – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development



Hosts

Cruciferous vegetables, canola, mustard, and weeds.

Identification

ADULTS: Medium-sized butterflies with black bodies covered with white pubescence, wing span of 45-65 mm. Forewings of males are creamy white with a black spot in the centre and black tips. Females also have two black spots in the center of the forewings. Undersides of the wings are yellowish with black speckles.

MATURE LARVAE: 25-30 mm long, green caterpillars with velvety textured body with scattered short hairs, a pale yellow line down the backline, a broken yellow line along each side, and a green head.

Life Cycle

Overwinters as a chrysalis suspended from host plants. Eggs laid singly on undersides of leaves. Two or three overlapping generations per year depending on seasonal weather conditions.

Feeding Damage

ADULTS: Feed on nectar of flowers.

LARVAE: Velvety green caterpillars that feed on cruciferous vegetables and on the leaves and pods of canola as well as on any cruciferous weeds in or around the crop.

Similar Species

Other species of green foliar-feeding caterpillars will be present; however cabbageworm larvae are distinctive by their uniform velvety appearance and pale yellow line down the back.

Monitoring/Scouting

None developed.

Economic Threshold

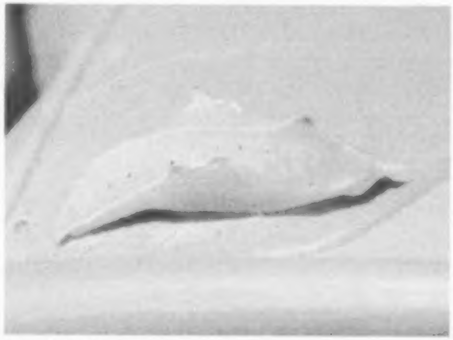
Although common in canola crops, they do not cause economic damage.

Management Options

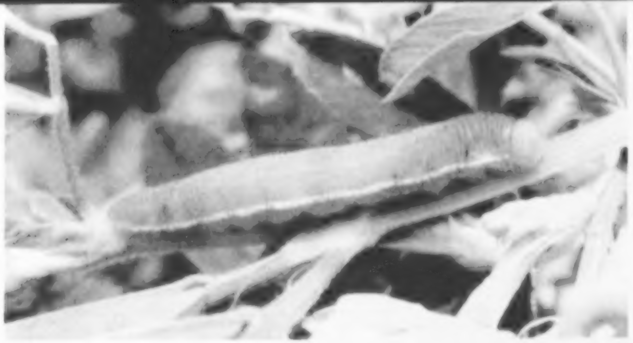
BIOLOGICAL: Populations are regulated by several species of parasitoids (e.g. *Cotesia glomerata* (Linnaeus) (p. 130), *Pteromalus puparum* (Linnaeus) (p. 137), *Trichogramma evanescens* Westwood (p. 138)) and predatory insects along with spiders, birds, and fungal and viral pathogens.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL: Insecticides applied against other pests will control any cabbageworm larvae present.



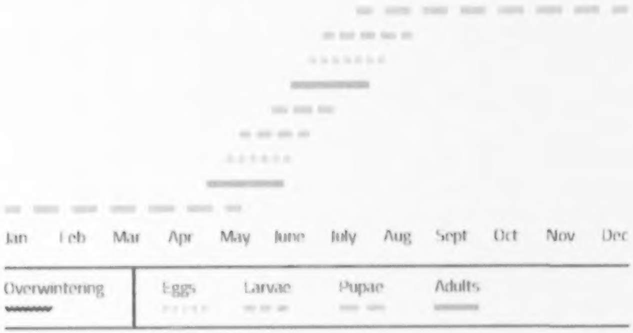
Imported cabbage worm – cocoon
Russ Ottens, University of Georgia, Bugwood.org



Alfalfa caterpillar – caterpillar
John Gavloski, Manitoba Agriculture, Food and Rural Development

Caterpillar, alfalfa

Colias eurytheme Boisduval



Alfalfa caterpillar – adult
Charles T. and John R. Bryson, Bugwood.org

Alfalfa caterpillar – adult
Charles T. and John R. Bryson, Bugwood.org

Hosts

Alfalfa, sweet clover, white clover, soybean, and hairy vetch; occasionally beans and peas; also feeds on vetch, milkvetch, trefoil, and other clovers (but not red clover).

Identification

ADULTS Butterfly with 25 mm long, body and 50 mm wingspan; wings are yellow, orange, or white with a black border on the upper surface and are solid white or yellow on the underside.

MATURE LARVAE Up to 30 mm long, velvety green caterpillars with prominent white stripe along each side with a fine reddish line in the middle.

Life Cycle

Overwinters as a chrysalis (pupa) anchored loosely to a plant stem, anterior end pointed upward, by means of a thread and a posterior anchor. Two generations per year.

Feeding Damage

ADULTS Feed on nectar from flowers.

LARVAE Under high population levels, larvae can strip leaves from smaller host plants. However, it has never been recorded causing economic damage to host crops in Western Canada.

Similar Species

Green cloverworm larva (p. 85) lacks the velvety green appearance and the alfalfa looper larva (p. 96) walks in a looping fashion and has the black line across the eyes.

Monitoring/Scouting

None developed.

Economic Threshold

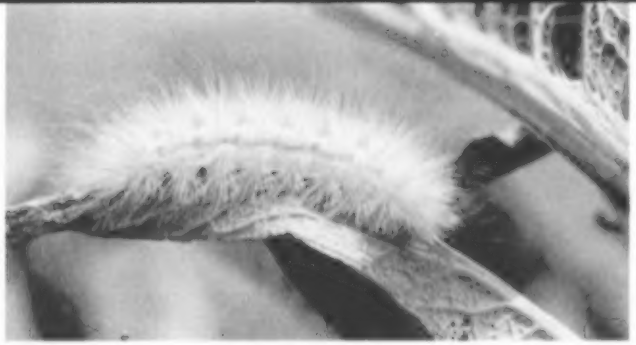
None established.

Management Options

BIOLOGICAL This species is regulated by generalist predatory insects. Spiders feed on eggs and larvae, along with egg and larval parasitoids, pathogenic fungi, and a virus.

CULTURAL Harvesting will kill or remove many eggs, larvae, and pupae present at the time.

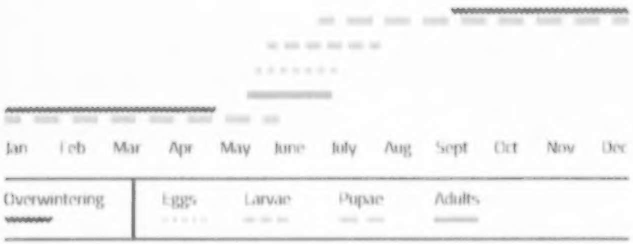
CHEMICAL Only required if noticeable defoliation and few diseased larvae or natural enemies present.

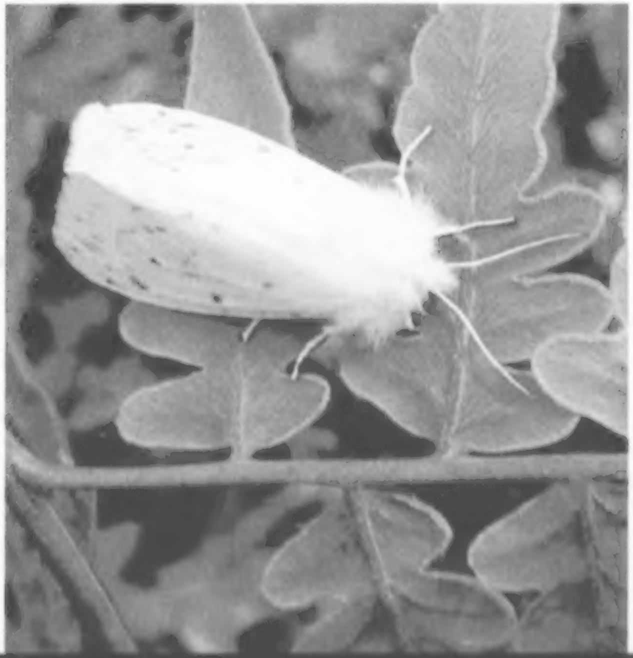


Saltmarsh caterpillar – caterpillar
Whitney Cranshaw, Colorado State University, Bugwood.org

Caterpillar, saltmarsh

Estigmene acrea (Drury)





Saltmarsh caterpillar – adult
Benny Mazur, Flickr

Hosts

Alfalfa, bean, beet, canola, carrot, clover, corn, pea, potato, soybean, sugar beet, and most vegetables, as well as berry and tree fruits.

Identification

ADULTS: Medium sized moths with white head and thorax and the abdomen is yellow-orange with a row of black spots. Forewing is white with a variable pattern of black spots, with some individuals lacking any spots; 45–68 mm wing span. Hindwing is yellow-orange in males and white in females. Both sexes have three or four black spots or blotches on the hindwings.

MATURE LARVAE: 25–30 mm long, very noticeable caterpillars ranging in colour from pale yellow to dark brownish-black with numerous stiff hairs in tufts which are longer toward the end of the body. The thoracic and abdominal segments have a few rows of orange or black warts. Crawl very fast when disturbed.

Life Cycle

Overwinters in protected sites as pupae in cocoons covered in hairs. The yellowish eggs are laid in large clusters on the undersides of host plant leaves. One generation per year.

Feeding Damage

ADULTS: Do not feed.

LARVAE: Feed on leaves but never in enough numbers to cause economic injury.

Similar Species

None that would be present in the same crops.

Monitoring/Scouting

None developed.

Economic Threshold

None established.

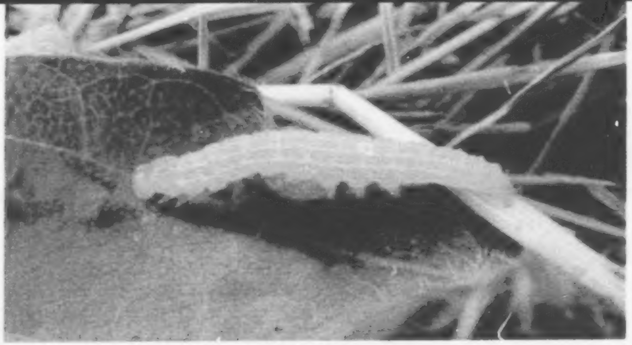
Management Options

BIOLOGICAL: Specific natural enemies are not known that can regulate pest populations.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL: None as not considered an economic pest.

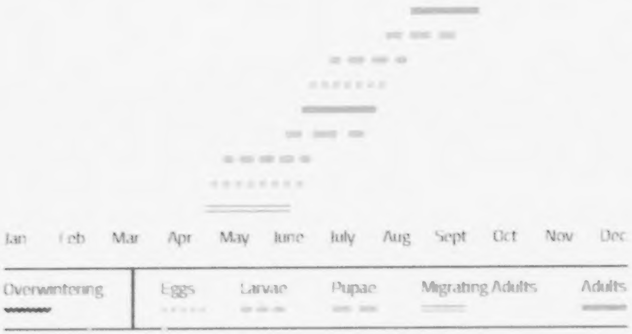
Saltmarsh caterpillar – caterpillar
Alton N. Sparks, Jr., University of Georgia, Bugwood.org

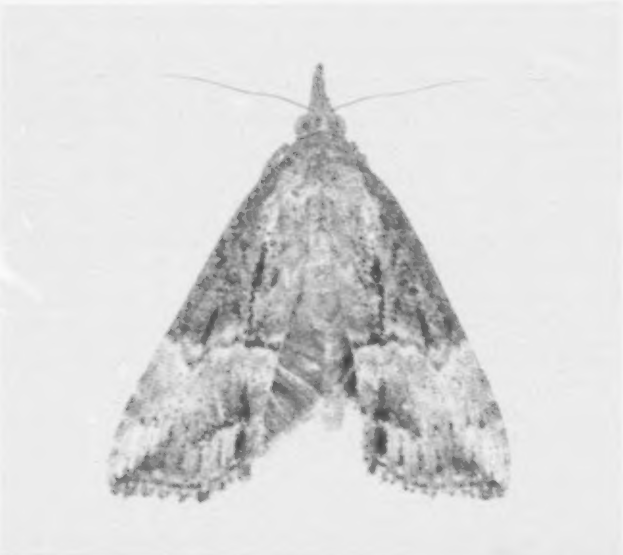


Green cloverworm – caterpillar
John Gavloski, Manitoba Agriculture, Food and Rural Development

Cloverworm, green

Hypena scabra (Fabricius)





Green cloverworm – adult
Mark Dreiling, Bugwood.org

Hosts

Soybean is a favoured host, but alfalfa, dry bean, clover, and pea are suitable hosts; other reported hosts include corn, birch, cherry, elm, poplar, ragweed, raspberry, strawberry, and willow.

Identification

ADULTS 14 mm long moths that form a triangle shape when at rest; forewings charcoal gray with patches of brown and silver; wing span of 25–35 mm. Head appears to have a snout.

MATURE LARVAE 25-30 mm long, pale green caterpillars with a white stripe down each side and three paler white lines down the back. They walk in a looping motion, and thrash violently when disturbed.

Life Cycle

Adults migrate up from the southern U.S. and females lay eggs singly or in clusters on available host plants on arrival. Larvae pupate in the soil. Two generations per year. Populations die off in the fall.

Feeding Damage

ADULTS Feed on nectar from flowers.

LARVAE All instars feed on leaves, occasionally defoliating plants. Also attack seed pods of legume hosts.

Similar Species

Alfalfa looper larvae (p. 96) also walk in a looping fashion but have fewer prolegs and have a black line on the eyes.

Monitoring/Scouting

Consult provincial agriculture web site or publications for recommended scouting methods.

Economic Threshold

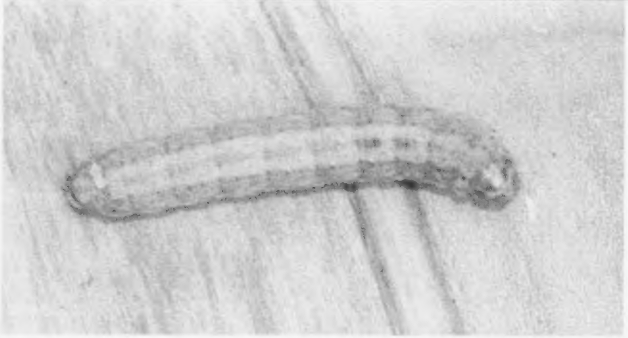
Use an economic injury level of 22.5 green cloverworms per metre of soybean row under normal to above-normal precipitation conditions. During drought, when canopy is seriously impaired, use an economic injury level of 10 green cloverworms per metre of soybean row.

Management Options

BIOLOGICAL Economic infestations are uncommon due to the several species of parasites, predatory insects, and fungal pathogens that attack eggs and larvae.

CULTURAL Specific cultural methods have not been developed; see also IPM section (p. 3).

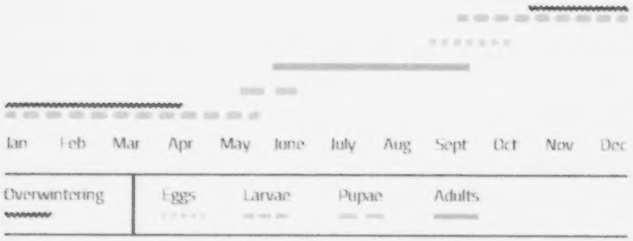
CHEMICAL None registered in Canada.

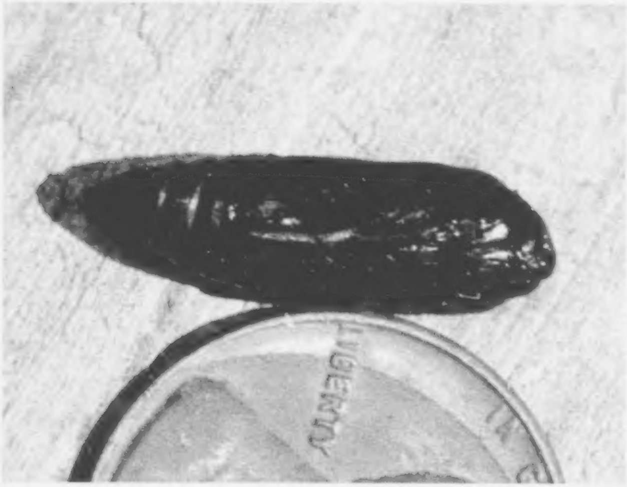


Army cutworm – caterpillar
Whitney Cranshaw, Colorado State University, Bugwood.org

Cutworm, army

Euxoa auxiliaris (Grote)





Army cutworm – pupa
Whitney Cranshaw, Colorado State University, Bugwood.org

Hosts

Wheat, oats, barley, canola, mustard, flax, alfalfa, sweet clover, peas, cabbage, sugar beet, various weeds (notably stinkweed), and grasses.

Identification

ADULTS: Larger grey-brown bodied moths with 40-45 mm wing span, with two prominent spots on each forewing.

MATURE LARVAE: 37-40 mm long, mottled pale greenish-grey to brown fleshy caterpillars with light brown, spotted head, and whitish stripe down middle of back.

Life Cycle

Overwinters as half-grown larvae in the soil. Adults spend summer in sheltered sites to escape heat. Eggs are laid in or on loose soil. One generation per year.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: All damage is done in the mid to late spring above ground (holes in leaves and notched margins until totally consumed). Larvae will move to other plants and up to 5 km in search of other host crops (hence "army") to continue feeding and complete development. Watch forage crops and pastures closely in April and early May for their presence or damage. Outbreak years are usually preceded by a year with an abnormally dry July and wet autumn.

Similar Species

Armyworm (p. 73) and fall armyworm (p. 76).

Monitoring/Scouting

In a 50 cm by 50 cm area of crop, record the number of larvae within each 50 cm of row in the sample area. Multiply the number of larvae by four to give the number of larvae per square metre. Repeat the process in different areas of the field.

Economic Threshold

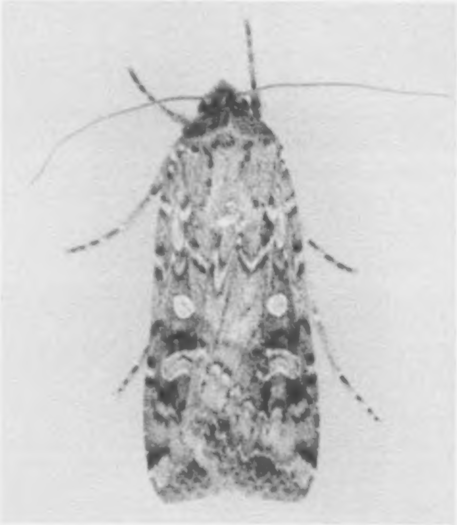
A nominal threshold of 5-6/m^2 can be used in cereal crops.

Management Options

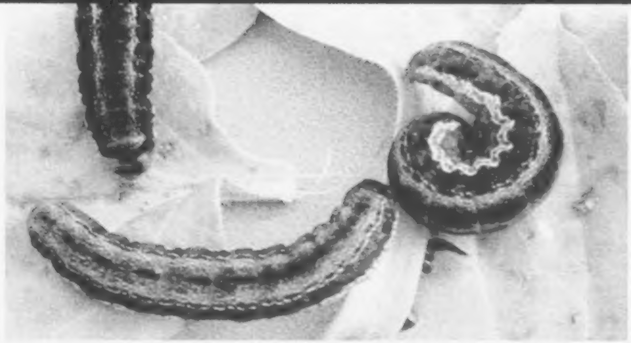
BIOLOGICAL: Several species of parasitoids (e.g. *Trichogramma minitum* Riley (p. 138)) attack eggs and larvae. Larvae also attacked by birds and predatory insects.

CULTURAL: Seed spring crops later to avoid larvae.

CHEMICAL: Apply treatments as based on provincial recommendations. Select products least harmful to beneficial insects.



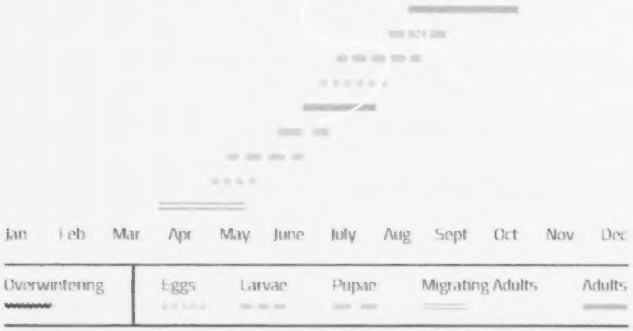
Army cutworm – adult
Mark Dreiling, Bugwood.org



Black cutworm – caterpillar
John Gavloski, Manitoba Agriculture, Food and Rural Development

Cutworm, black

Agrotis ipsilon (Hufnagel)
(a.k.a. Dark sword-grass cutworm)



Cutworm – damage
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

Corn is a major host, but pest feeds on a wide range of field and garden crops including alfalfa, clover, sunflower, asparagus, bean, beet, cabbage, lettuce, field peas, pepper, potato, radish, spinach, squash, strawberry, and tomato; favoured weed hosts include bluegrass, curled dock, lamb's-quarters, yellow rocket, and redroot pigweed.

Identification

ADULTS: 20 mm long body with long, narrow, usually dark forewings which are pale near the tips with three black dashes on each forewing. Wing span varies from 38-50 mm.

MATURE LARVAE: Up to 46 mm long, smooth and ranges from purplish to brown in colour. Patterned with grey lines and spots.

Life Cycle

Moths move up from the southern U.S. each spring; females lay eggs on weed and grass hosts in fields or margins. One or two larval generations per year before populations die off in the fall.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: The first generation of larvae is the most damaging. Most sever young plants from roots near the soil line as they feed at the base of the leaves; others feed on the roots and underground stems of cut plants. One larva can kill many plants until it pupates in the soil.

Similar Species

Other cutworm larvae share the same feeding behaviour, general appearance, and curl up when handled. Fall armyworm (p. 76) and armyworm (p. 73) larvae may also be present.

Monitoring/Scouting

Monitor germinating crop for expanding thinned or bare areas. See pale western cutworm for sampling methods in cereals. Depending on crop, other species of cutworms may be present. In corn, examine 10 plants in row at ten sites and estimate the percentage of dead or severed plants.

Economic Threshold

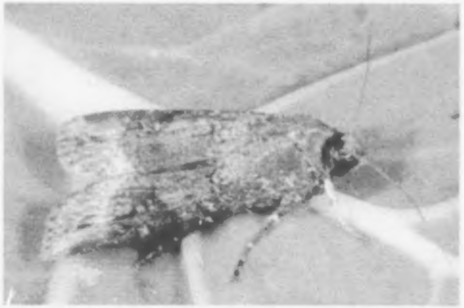
Thresholds vary according to crop. Cereals, 3-4 larvae/m^2 ; oilseeds, 25-30% stand reductions; pea, 2-3 larvae/m^2 in top 7 cm of soil.

Management Options

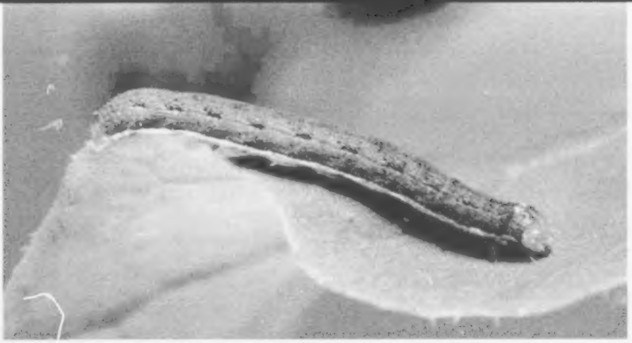
BIOLOGICAL: Ground beetles (p. 115) will attack exposed larvae on soil surface; similar to other cutworms and armyworms, eggs and larvae are attacked by insect parasitoids (e.g. *Cotesia marginiventris* (Cresson) (p. 130), Trichogramma minitum Riley (p. 138)) and predators.

CULTURAL: Avoid planting corn on newly broken sod or on land which was grassy or weedy the previous summer; use planting practices that encourage rapid, vigorous seedling development.

CHEMICAL: As with other subterranean cutworms, apply necessary foliar treatments in the evening just before larvae emerge from the soil to feed. Only infested areas need to be treated.



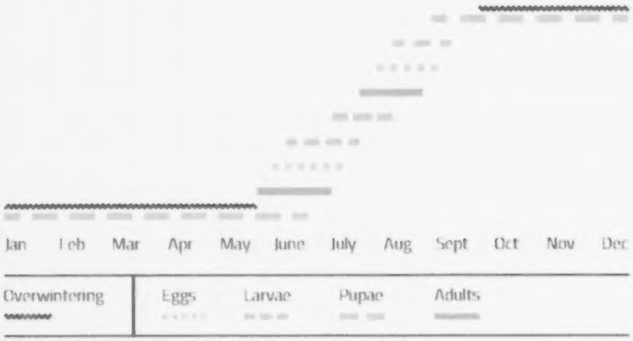
Black cutworm – adult
Merle Shepard, Gerald R.Carner and P.A.C. Ooi, Bugwood.org

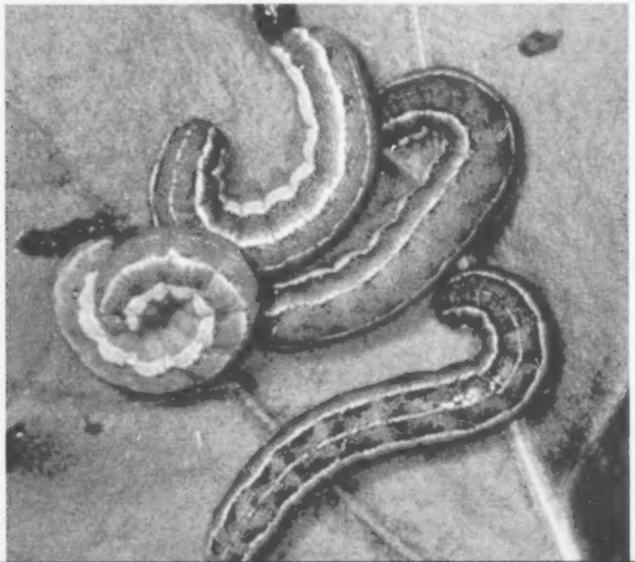


Clover cutworm – caterpillar
AAFC

Cutworm, clover

Discestra trifolii (Hufnagel)





Clover cutworm – caterpillar
AAFC

Hosts

Canola, mustard, and flax are major field crop hosts; other hosts include cruciferous weeds, sugar beets, clover, and some forages.

Identification

ADULTS Uniform or mottle ashy-grey to pale brownish-grey forewings, with 25-36 mm wing span.

MATURE LARVAE Up to 40 mm long, velvety black (occasionally green) caterpillars with a light brown head and a broad, yellowish-pink stripe along each side and three narrow, broken white lines down their backs.

Life Cycle

Overwinter as pupae 5-16 cm below soil surface; eggs laid singly on leaves. Two generations per year (the first most damaging).

Feeding Damage

ADULTS Feed on nectar of flowers.

LARVAE Larvae feed on undersides of leaves before feeding on all parts as they mature, similar to bertha armyworm larvae (p. 74).

Similar Species

Similar in appearance and size to bertha armyworm larvae (p. 74), but fewer velvety black caterpillars are found and the majority are either green or pale brown. Also, the lateral band is yellowish-pink rather than yellowish-orange as on bertha armyworm.

Monitoring/Scouting

Same as for bertha armyworm (p 74). In canola and mustard, because of the patchy distribution of infestations, also watch for crop areas showing greater damage (lighter shaded to white).

Economic Threshold

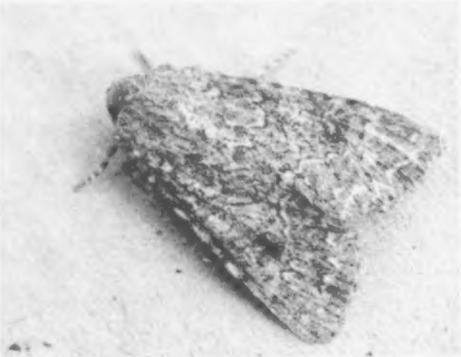
Not established; as a nominal threshold in canola use the same level as for bertha armyworm (p. 74).

Management Options

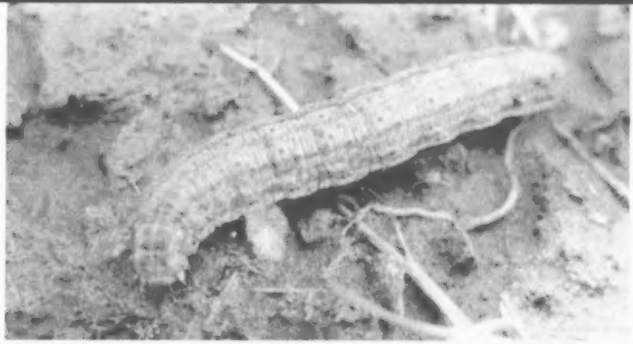
BIOLOGICAL A virus disease of larvae can reduce populations through the summer; eggs and larvae are also subject to attack by insect parasitoids (e.g. *Trichogramma minitum* Riley (p. 138)) and predators.

CULTURAL Similar to bertha armyworm.

CHEMICAL Apply required foliar treatments in early morning or late evening when larvae are feeding. Because of the patchy nature of infestations, spray only where pest pressure warrants.



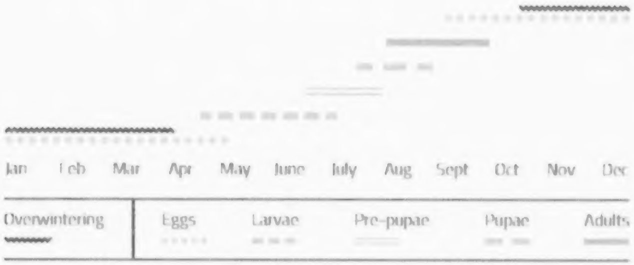
Clover cutworm – adult
Entomart, Wikipedia



Darksided cutworm – caterpillar
John Gavloski, Manitoba Agriculture,
Food and Rural Development

Cutworm, darksided

Euxoa messoria (Harris)



Hosts

Very broad spectrum of herbaceous and woody hosts including vegetables, cereals, canola, corn, flax, sunflower, and vine, berry, and tree fruits.

Identification

ADULTS 20 mm long, robust moth with grayish brown body and wing span of 32–36 mm. Grayish forewings each have an oval and a kidney-shaped paler spot with darker margins among irregular dark lines.

MATURE LARVAE Up to 37 mm long, fleshy grayish caterpillars with a prominent white stripe along each side just above the legs, and a reddish background colour along back. Head is orange-brown with darker spots.

Life Cycle

Overwinters as eggs laid in the soil or under debris in cultivated fields the previous fall. Mature larvae have a pre-pupa stage for about 30 days prior to pupating. Females lay up to 1000 eggs on the soil under soil clumps and plant debris. One generation per year.

Feeding Damage

ADULTS Feed on nectar from flowers.

LARVAE Feed on the leaves and stems of young plants at night, sometimes causing complete defoliation and death of the plant. Hide during the day at the base of plants or in the soil. Gradually increasing areas of bare soil soon after the crops have emerged indicates possible cutworm feeding damage.

Similar Species

Other species of cutworms may be present depending on crop. Larvae are easily confused with those of the redbacked cutworm (p. 93).

Monitoring/Scouting

Use light and pheromone traps to detect adults, however the number captured does not reflect the risk of economic infestations. Inspect areas where plants are thinning or the edges where bare soil is increasing for larvae hiding under debris or in the soil (day) or feeding on the plants (night). Estimate the percentage of plants destroyed by their feeding.

Economic Threshold

A nominal threshold of 5–6 larvae/m^2 can be used.

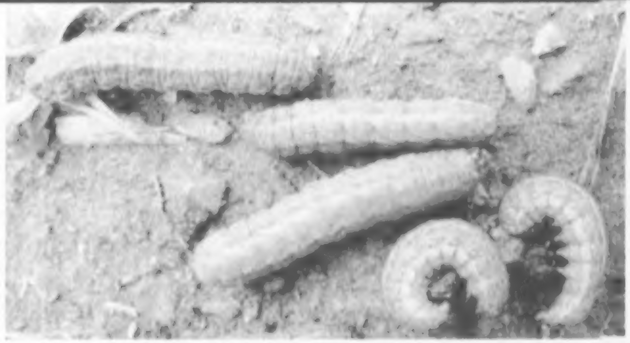
Management Options

BIOLOGICAL Attacked by several larval and egg parasitoids (e.g. *Trichogramma minitum* Riley (p. 138)) and generalist predatory insects as well as birds and rodents.

CULTURAL Delaying seeding by 10–14 days when eggs start hatching will starve many young larvae.

CHEMICAL As with other cutworms, apply necessary foliar treatments in the evening just before larvae emerge from the soil to feed. Only infested areas need be treated.

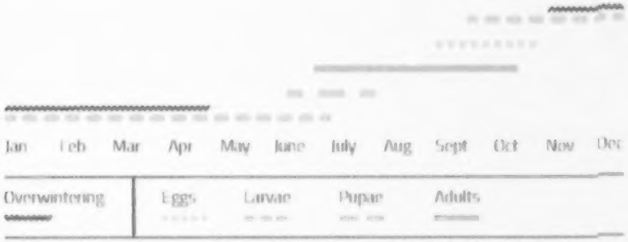
Darksided cutworm – pupa
John Gavloski, Manitoba Agriculture,
Food and Rural Development



Dingy cutworm – caterpillar
John Gavloski, Manitoba Agriculture, Food and Rural Development

Cutworm, dingy

Feltia jaculifera (Guenée)



Hosts

Sunflowers, alfalfa, corn, flax, canola, oats, barley, rye, and wheat; many other vegetable, grass, ornamental, and weed hosts.

Identification

ADULTS: 20 mm long moth with 35-40 mm wing span; forewings are dark brown with pale stripes and bean shaped markings.

MATURE LARVAE: 25-32 mm long, fleshy caterpillar with a broad gray stripe down the back with light gray V shaped patterns and four black spots on each segment.

Life Cycle

Overwinters as partially grown larvae that complete development in the spring. Females lay eggs in the soil near host plants, especially in weedy, moist areas of fields. Larvae feed in fall before burrowing into the soil to overwinter. One generation per year.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: Most severe damage occurs in the spring when partially mature larvae emerge to feed on young crops. Larvae feed primarily above ground on leaves and only rarely on stems.

Similar Species

Larvae of other species of cutworms described in this guide may be present depending on the crop.

Monitoring/Scouting

Monitor germinating crop for areas of thinning crop or expanding bare soil. In areas where cutworm damage is noticed, check around damaged plants in a 50 cm X 50 cm area for cutworms. Use a trowel or shovel to search through top 2-6 cm of soil.

Economic Threshold

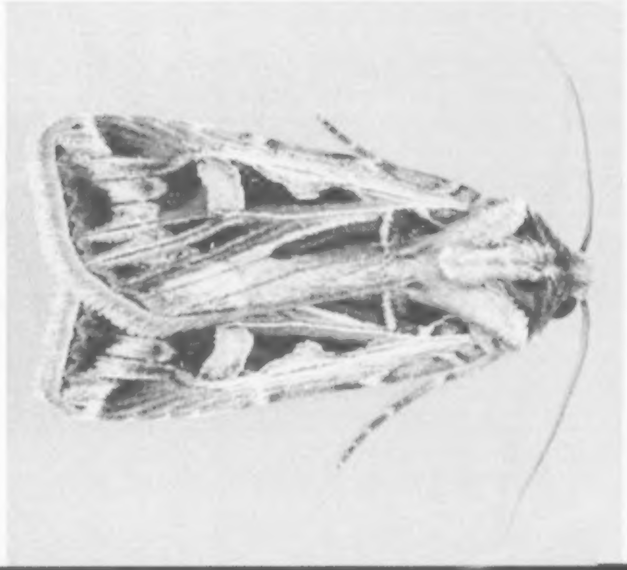
Thresholds vary according to crop. Cereals, 3-4 larvae/m^2 ; oilseeds, 25-30% stand reductions; pea, 2-3 larvae/m^2 in top 7 cm of soil.

Management Options

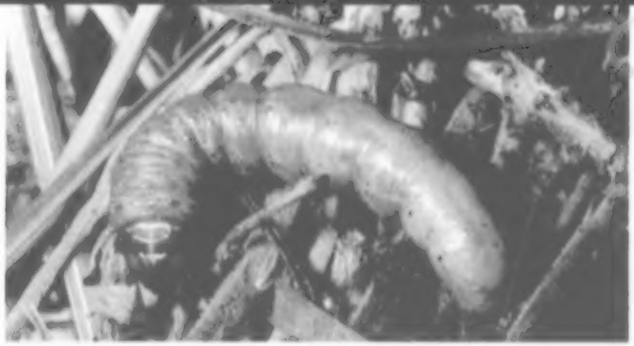
BIOLOGICAL: Several species of parasitoids (*Trichogramma minitum* Riley (p. 138)) and predatory insects and spiders attack eggs and larvae.

CULTURAL: Control of weed hosts in fallow fields and post-harvest will reduce attraction of females for egg laying. Spring and fall cultivation will expose larvae to predation by birds and predatory insects.

CHEMICAL: As with other climbing cutworms, apply necessary foliar treatments in the evening just before larvae begin to feed. Only infested areas need to be treated.



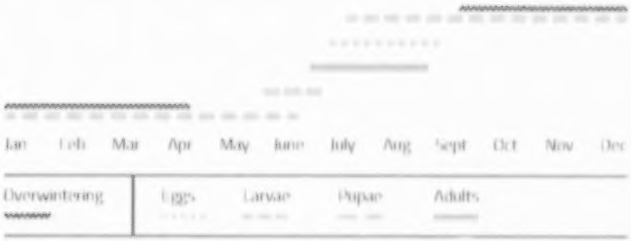
Dingy cutworm – adult
Mark Dreiling, Bugwood.org



Glassy cutworm – caterpillar
Mike Dolinski, MikeDolinski@hotmail.com

Cutworm, glassy

Apamea devastator (Brace)



Hosts

Grasses are the preferred hosts; occasional damage reported to cereals and corn.

Identification

ADULTS: 20–25 mm long, greyish-brownish body and wings with several dark spots (35–40 mm wing span).

MATURE LARVAE: 35–40 mm long, with a glossy, semi-translucent greenish-white or grey body without body markings, and a reddish brown head and neck shield. Larvae curl up when disturbed similar to other cutworm larvae.

Life Cycle

Overwinters as young larvae that resume feeding in the early spring. They pupate in soil cells. Females lay their eggs in the soil near host plants.

Feeding Damage

ADULTS: Feed on nectar from flowers.

MATURE LARVAE: Larvae feed underground on the plant crowns and roots, or in the case of bunch grasses, within the crown and rarely come to the surface. They often clip off more leaves than they can consume. Outbreaks can last 2–3 years.

Similar Species

Related species that may be present with glassy cutworm include *Apamea inficita* (Walker) (lined Quaker moth), *A. amputatrix* (Fitch) (yellowheaded cutworm), and *A. cogitate* Smith (thoughtful apamea moth). Other cutworms (e.g. dingy [p. 90], pale western [p. 92], redbacked [p. 93], variegated [p. 94]) and sod webworms (*Crambus* spp.) may also be present.

Monitoring/Scouting

In the fall and early spring, check for larvae in fields at risk by examining the roots, crowns, and nearby soil of plants showing browned or clipped leaves or slow growth.

Economic Threshold

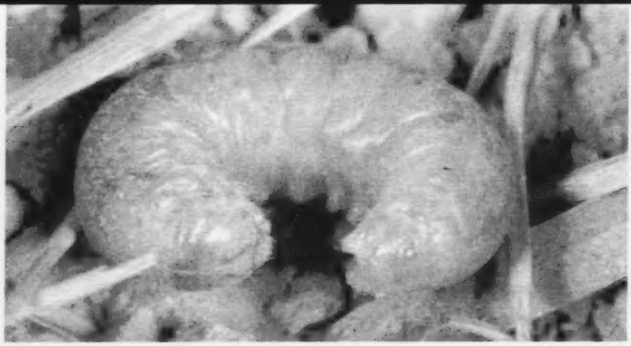
None established.

Management Options

BIOLOGICAL: Several species of braconid, ichneumonid, trichogramids (e.g. *Trichogramma minitum* Riley (p. 138)) and tachinid parasitoids and generalist predators feed on larvae and eggs.

CULTURAL: Newly broken land and summer fallow with grassy weeds should be well cultivated during August to prevent new growth suitable for egg laying and larval feeding.

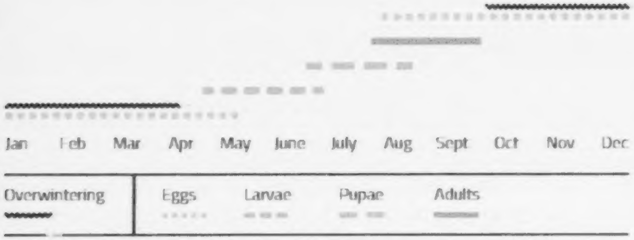
CHEMICAL: If insecticide treatment is required, apply using a high water volume (200 L/ha) to ensure the product reaches the larvae beneath and within the plant foliage. Applying treatments just before rains or irrigation improves the level of control.



Pale western cutworm – caterpillar
Frank Peairs, Colorado State University, Bugwood.org

Cutworm, pale western

Agrotis orthogonia (Morrison)



Hosts

Cereals (wheat preferred), canola, mustard, flax, corn, sugar beets, legumes, and certain weeds.

Identification

ADULTS 19 mm long moth with light gray forewings with indefinite markings; 38 mm wing span.

MATURE LARVAE Up to 40 mm long, pale gray to greenish gray fleshy caterpillars without distinguishing markings except for the yellow-brown head which has two distinct vertical black dashes.

Life Cycle

Overwinter as eggs in the top centimeter of soil. Larvae pupate in earthen cells. One generation per year.

Feeding Damage

ADULTS Feed on nectar of flowers.

LARVAE Young larvae feed on leaves before they emerge (small holes). As they mature they move along rows cutting off leaves and severing plants just below soil level to eat them underground.

Similar Species

Other subterranean cutworm larvae that may be present include the redbacked cutworm (p. 91) and black cutworm (p. 85).

Monitoring/Scouting

Pheromone traps are available to detect emergence of adults. Monitor germinating cereal crops for expanding thinned or bare areas, especially sandy ridges and knolls. At a minimum ten sites, mark off 0.1m^2 area (1 ft^2) and examine the top 2-3 cm of soil along the edges of the affected areas for larvae.

Economic Threshold

3-4 larvae/m^2.

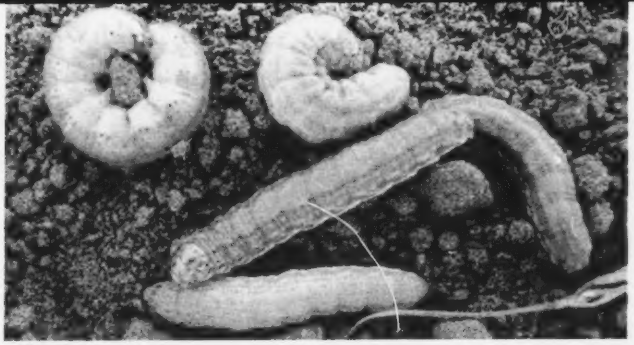
Management Options

BIOLOGICAL Several species of parasitoids (e.g. *Trichogramma minitum* Riley (p. 138)) and predatory insects attack eggs and larvae. Very high larval parasitism is usually responsible for ending outbreaks after 2 years.

CULTURAL Weed-free uncultivated fields in August to mid-September are less attractive to females for egg laying. If volunteer cereals show signs of feeding damage, cultivating the soil and keeping it black for 10 days before seeding will starve many young larvae.

CHEMICAL Apply in the late evening when larvae begin feeding, and only to infested areas. Those larvae that do not contact residues on the soil surface will be exposed when they pull treated leaves into the soil to feed. Infested fields should be sprayed before reseeding.

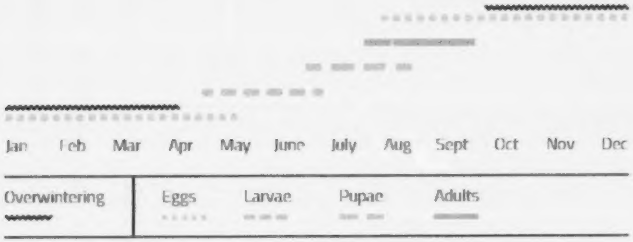
Pale western cutworm – damage
Frank Peairs, Colorado State University, Bugwood.org

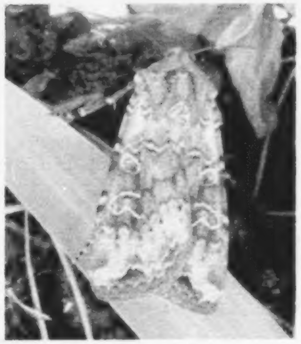


Redbacked cutworm – caterpillar
John Gavloski, Manitoba Agriculture, Food and Rural Development

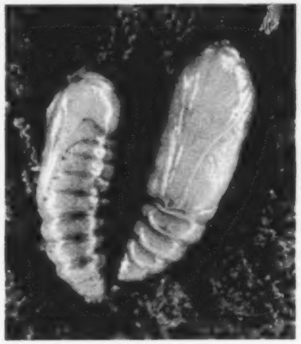
Cutworm, redbacked

Euxoa ochrogaster (Guenée)





Redbacked cutworm – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development



Redbacked cutworm – pupa
John Gavloski, Manitoba Agriculture, Food and Rural Development

Hosts

Cereals, flax, canola, corn, mustard, sunflower, sugar beets, forage legumes, vegetables, and many other crops.

Identification

ADULTS Forewings are fawn to brick-red in colour; 40 mm wing span.

MATURE LARVAE 38 mm long, fleshy caterpillars with a reddish-brown strip extending down the back that has a centre dark line bordered by a dark band on each side.

Life Cycle

Overwinter as eggs in the top centimeter of soil. Larvae pupate in earthen cells. One generation per year.

Feeding Damage

ADULTS Feed on nectar of flowers.

LARVAE Young larvae feed on leaves before they emerge (small holes). As larvae mature they move along rows cutting off leaves and severing plants just below soil level to eat them underground.

Similar Species

Other cutworm larvae that may be present include the pale western cutworm (p. 92) and black cutworm (p. 87).

Monitoring/Scouting

Pheromone traps are available to detect emergence of adults. Monitor germinating cereal crops for expanding thinned or bare areas, especially sandy ridges and knolls. At a minimum ten sites, mark off 0.1m^2 area (1 ft^2) and examine the top 5–7 cm of soil along the edges of the affected areas for larvae.

Economic Threshold

A nominal threshold of 5-6 larvae/m^2 can be used.

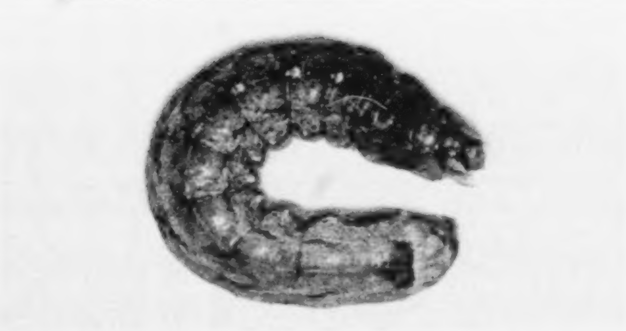
Management Options

BIOLOGICAL Several species of parasitoids (e.g. *Trichogramma minitum* Riley (p. 138))and predatory insects attack eggs and larvae. Very high larval parasitism is usually responsible for ending outbreaks.

CULTURAL Weed-free uncultivated fields from late July to end September are less attractive to females for egg laying.

CHEMICAL Apply in the late evening when larvae begin feeding, and only to the infested areas. Those larvae that do not contact residues on the soil surface will be exposed when they eat treated leaves. Infested fields should be sprayed before reseeding.

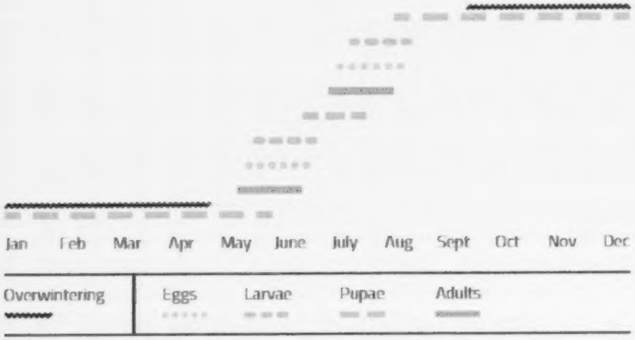
Redbacked cutworm – damage
MFC

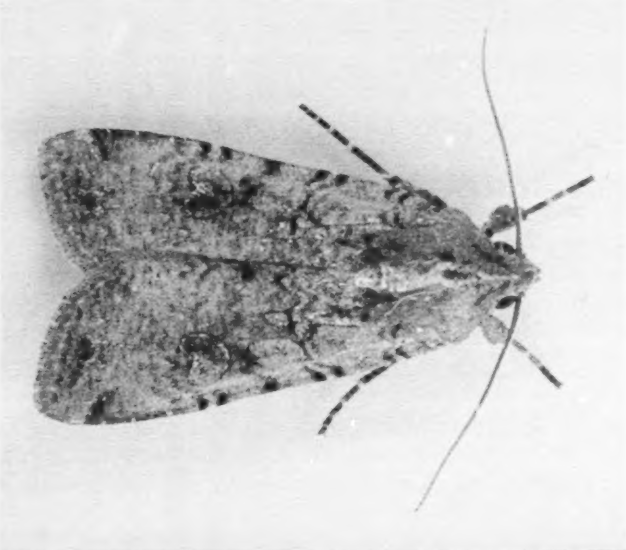


Variegated cutworm – caterpillar
James Kalisch, University of Nebraska, Bugwood.org

Cutworm, variegated

Peridroma saucia (Hübner)





Variegated cutworm – adult
Mark Dreiling, Bugwood.org

Hosts

Corn, beans, alfalfa, cereals, sweet clover, potatoes, soybean, garden crops, trees, vines, grasses, ornamentals, and greenhouse plants.

Identification

ADULTS: Forewings are yellow or brown with a pale oval marking near the wing edge, adjacent to a darker kidney-shaped marking; 45–50 mm wing span.

MATURE LARVAE: 35-40 mm long, smooth fleshy caterpillar, pale gray or light brown mottled with dark brown. The first four abdominal segments (at least) bear two yellow or orange dots while the eighth segment is marked with both a black spot and a yellow spot. There is a narrow, orange-brown stripe along the side. They curl up when disturbed, like other cutworms.

Life Cycle

Overwinter as pupae in soil cells. Moths may also migrate up from the U.S. throughout the season. Up to 2000 eggs/female are laid in clusters of 60+ on host plants. Two or three larval generations per year depending on weather conditions.

Feeding Damage

ADULTS: Feed on nectar of flowers.

LARVAE: Climb up plants at night to feed on foliage, flowers, buds, and fruits. They do not clip plants off at ground level like subterranean cutworms.

Similar Species

Other species of cutworm and armyworm larvae may be present. Variegated cutworm larvae are distinguished by 4 to 7 pale yellow, circular spots on their backs.

Monitoring/Scouting

Use pheromone traps to detect appearance of adults. When leaf damage appears, use a sweep net at night to scout for feeding larvae; during the day, examine the top 3-6 cm of soil around the plants for the larvae.

Economic Threshold

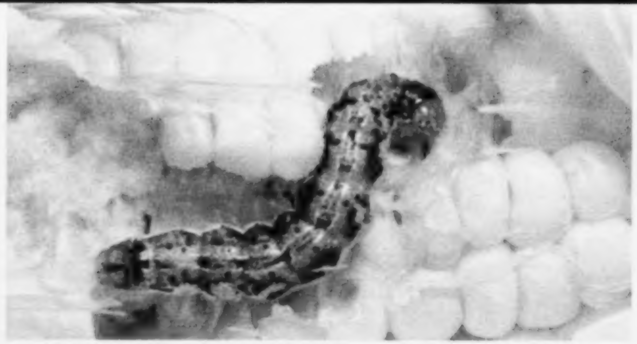
None specific for this pest; for other cutworms 2–4 larvae/m^2 can cause significant injury or loss depending on crop.

Management Options

BIOLOGICAL: Several species of parasitoids (e.g. *Cotesia marginiventris* (Cresson) (p. 130), *Trichogramma minitum* Riley (p. 138)) and predatory insects attack the eggs and larvae.

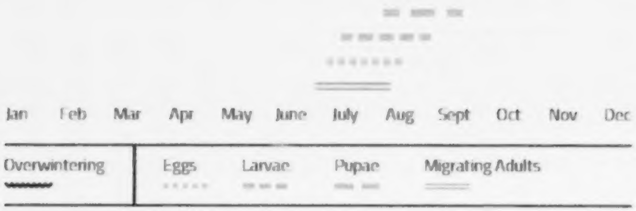
CULTURAL: Fields free of weed and volunteer crop hosts are less attractive for egg laying.

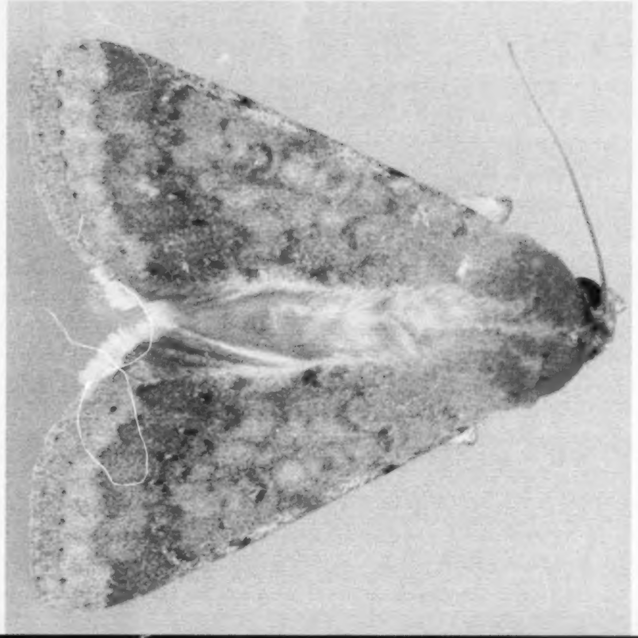
CHEMICAL: Apply in the evening when cutworms emerge from the soil to feed.



Corn earworm – caterpillar, damage
Sturgis McKeever, Georgia Southern University, Bugwood.org

Earworm, corn
Helicoverpa zea (Boddie)





Corn earworm – adult
Mark Dreiling, Bugwood.org

Hosts

Sweet corn is the major economic host; tomatoes are also attacked.

Identification

ADULTS: Stout-bodied moths with 35-40 mm wing span. Forewings vary greatly in colour from pale tan to dark brown, each with dark brown spots in middle towards front edge and a broad lighter shaded band along the leading edge. Eyes are bright green.

MATURE LARVAE: 37 mm long, fleshy caterpillars that vary in colour from yellow-brown to grey-green and with horizontal alternating light and dark bands along the back.

Life Cycle

Adults migrate up from southern U.S. and Mexico, usually arriving by mid to late summer (depending on winds); eggs are laid on newer leafs or silks; larvae pupate in soil cells. Larvae and any pupae are killed by fall frosts. Threat to sweet corn depends on number of females arriving and stage of corn development.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: Feeding during whorl stage causes tattered leaves, usually on isolated plants; during silk stage, larvae tunnel into the tips to feed on the silk and developing kernels. Feeding damage reduces the quality and marketability of the ears.

Similar Species

European corn borer (p. 79) and fall armyworm (p. 76) may be present on corn at the same time.

Monitoring/Scouting

Pheromone lures and traps are available to capture male moths.

Economic Threshold

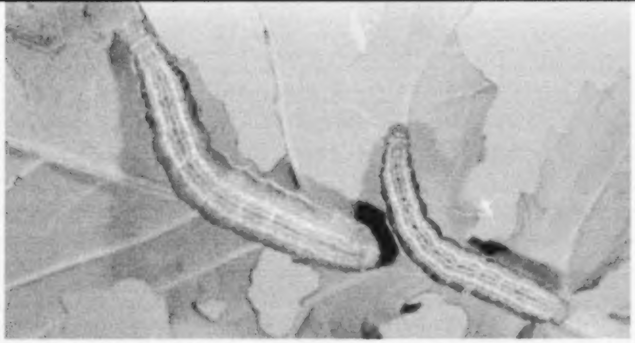
None established.

Management Options

BIOLOGICAL: Attacked by the parasitoids *Cotesia marginiventris* (Cresson) (p. 130) and *Trichogramma evanescens* Westwood (p. 138), however it and other natural enemies are not considered a factor due to the late season appearance of this intermittent pest.

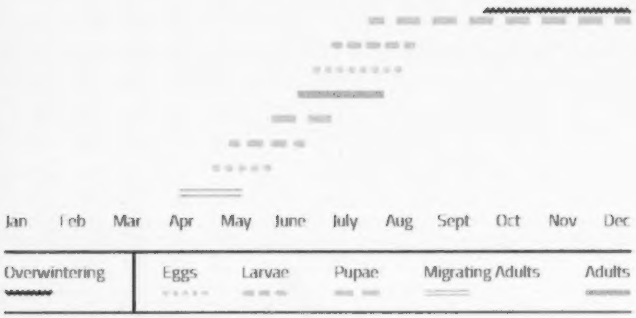
CULTURAL: Plant corn earlier or plant earlier maturing varieties to avoid larvae; some transgenic corn varieties may provide some suppression.

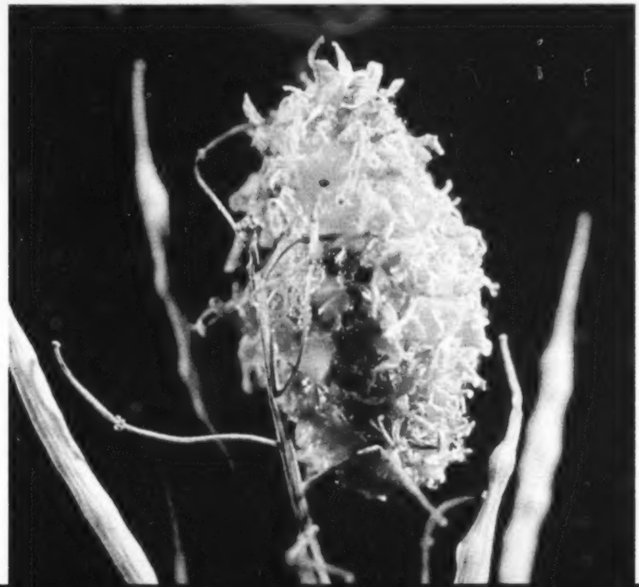
CHEMICAL: Protection of field corn is not considered economical. To protect sweet corn ears, treatments must be applied throughout the silk stage to kill larvae before they tunnel into the tips.



Alfalfa looper – caterpillar, damage
AAFC

Looper, alfalfa
Autographa californica Speyer





Alfalfa looper – cocoon
AAFC

Hosts

Prefer alfalfa, clover, and lettuce. Other hosts include canola, peas, spinach and various garden crops, ornamental trees, and tree fruits.

Identification

ADULTS: Dull grey or brown bodied moth with silvery-grey forewings (30-38 mm wing span), each with a distinct yellowish sickle-shaped spot near its centre.

MATURE LARVAE: 25 mm long, light to olive-green with paler head and slightly swollen abdomen; walk in a looping fashion (3 pairs of prolegs).

Life Cycle

Most moths seen in the spring blew in from the U.S. although some may have emerged from the few pupae overwintering in the soil. Two or three overlapping generations of larvae per year depending on weather conditions.

Feeding Damage

ADULTS: Feed on nectar from flowers and are active during the day.

LARVAE: Canola—First generation larvae feed along leaf margins and may defoliate a large portion of the plant as well as clip flowers and seed pods. Infestations are usually patchy and during flowering. Second generation larvae are usually not a problem (see below).

Alfalfa—Similar injury as for canola; first cut regrowth at risk under high population pressure.

Similar Species

Adults can be confused with the cabbage looper (*Trichoplusia ni* (Hübner)) and celery looper (*Anagrapha falcifera* (Kirby)); alfalfa caterpillar (*Colias eurytheme* Boisduval (p. 83)) and imported cabbageworm (*Pieris rapae* (Linnaeus) (p. 82)) may also be present.

Monitoring/Scouting

Beat canola plants in an area 50 cm x 50 cm and record the number of larvae on the ground. Repeat this procedure several times in different locations to obtain an average number of larvae per square metre for the field.

Economic Threshold

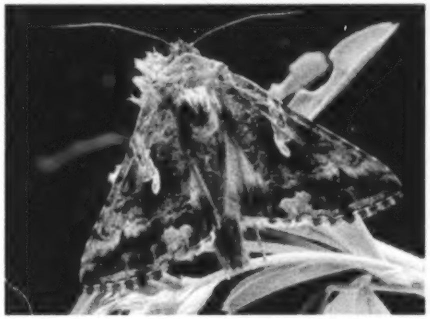
No economic threshold has been established in canola. However, more than 15 larvae per square metre, combined with heavy defoliation or flower and pod clipping, may warrant control.

Management Options

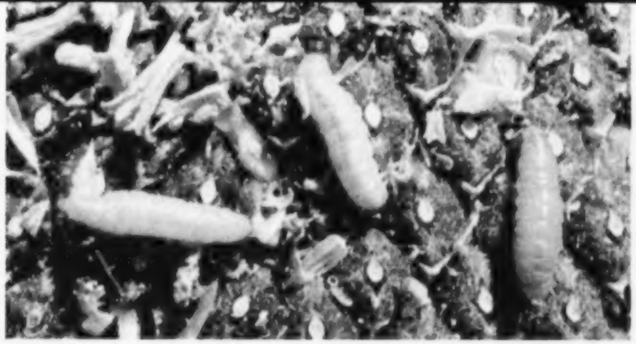
BIOLOGICAL: A virus disease causes significant mortality of first generation 5th–6th instar larvae, terminating most infestations. Infected larvae hang from host plants dripping virus-infested body fluids that infect other larvae. Several species of generalist predators and some parasitoids (e.g. *Cotesia marginiventris* (Cresson) (p. 130)) attack eggs and larvae.

CULTURAL: For alfalfa, harvest as soon as noticeable defoliation occurs. Watch regrowth for larval feeding injury.

CHEMICAL: Control products available but rarely required for protection of canola or alfalfa crops.



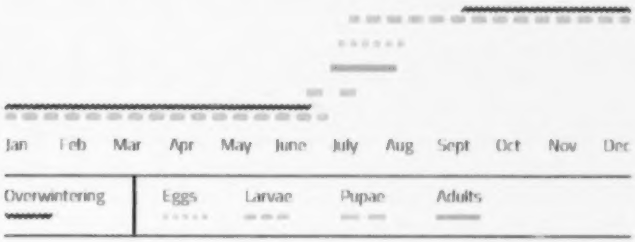
Alfalfa looper – adult
Peggy Greb, USDA Agricultural Research Service, Bugwood.org

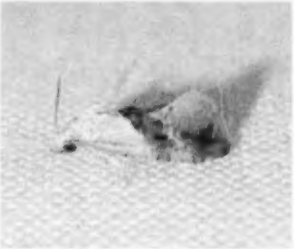


Banded sunflower moth – caterpillar
John Gavloski, Manitoba Agriculture, Food and Rural Development

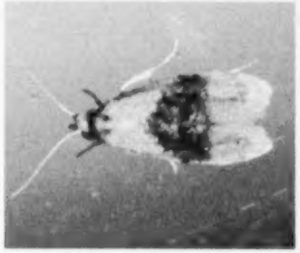
Moth, banded sunflower

Cochylis hospes (Walsingham)





Banded sunflower moth – adult
Susan Elliott, iNaturalist.org



Banded sunflower moth – adult
Robert Lord Zimlich

Hosts

Sunflower

Identification

ADULTS: 7 mm long, straw-colored moth with a brown triangular area in the middle portion of the fore wings.

MATURE LARVAE: 10 mm long, green caterpillars that began as light pink or yellow, then to reddish or purplish, and finally green in colour.

Life Cycle

Overwinters as mature larvae in the soil. Females move from previously infested fields into the new crops to lay eggs during the evening on the bracts of sunflower heads.

Feeding Damage

ADULTS: Feed on nectar from flowers.

MATURE LARVAE: As larvae mature they feed on bracts, florets, and developing seeds (6-7 seeds consumed/larva), reducing yield of intact seed. Entry/exit holes are evident near the top of seeds. Most damage occurs on crop margins nearest previously infested fields.

Similar Species

A related species, Arthur's sunflower moth (*Cochylis arthuri* Dang), has been reported infesting sunflowers in Saskatchewan. Because the feeding damage is similar to that of the banded sunflower moth, it is not necessary to distinguish the two species for pest management purposes. Also, seed damaged by banded sunflower moth larvae resemble those fed on by red sunflower seed weevil (p. 31).

Monitoring/Scouting

When plants are in the late bud (R-4) to early bloom stage (R-5.1), look for moths in the early evening or early morning on 20 plants from 5 different sites (total of 100 plants). Sampling sites should be at least 20-30 m from the field margin.

Economic Threshold

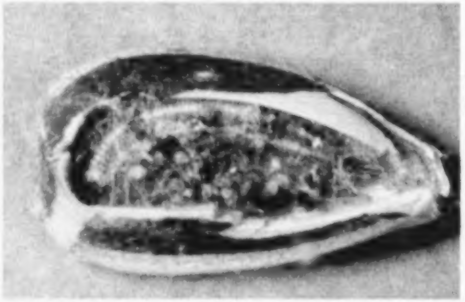
One moth/two plants if counted in early evening or morning.

Management Options

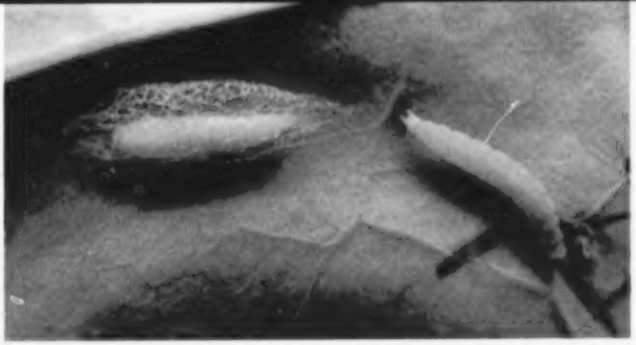
BIOLOGICAL: Several species of parasitoids (e.g. *Chelonus phaloniae* Mason (p. 130), *Glypta prognatha Dasche* (p. 135)) and generalist predators feed on larvae and eggs.

CULTURAL: Although practices such as tillage and planting date have been effective in reducing damage from the banded sunflower moth, growers should be aware of all the insect pests they are likely to have and also the effect of planting date on yield potential.

CHEMICAL: Apply required treatment at the R-5.1 growth stage, and early in the morning or late in the day to minimize the adverse effect on bees and other pollinators.



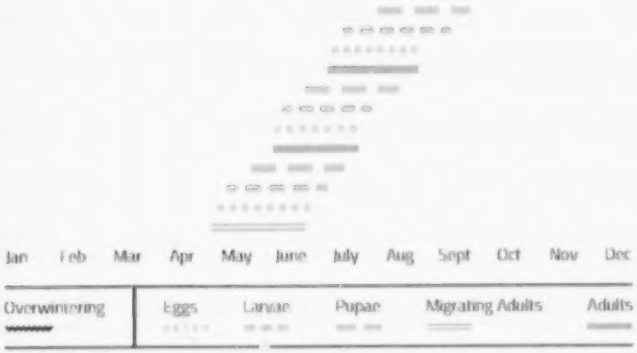
Banded sunflower moth – caterpillar, damage
Frank Peairs, Colorado State University, Bugwood.org

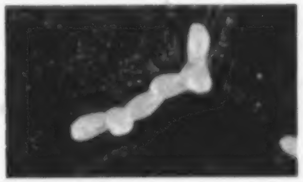


Diamondback moth – caterpillar, cocoon
John Gavloski, Manitoba Agriculture, Food and Rural Development

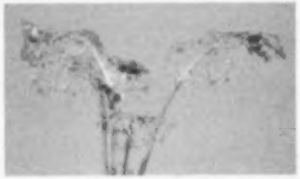
Moth, diamondback

Plutella xylostella (Linnaeus)

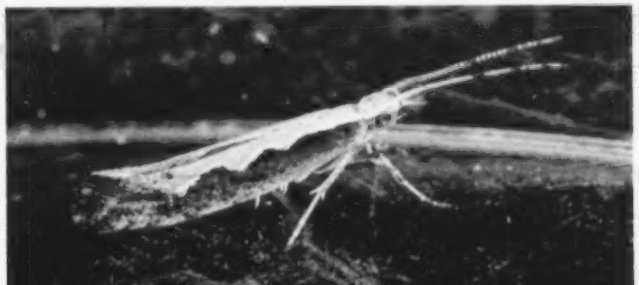




Diamondback moth – eggs
AAFC



Diamondback moth – damage
AAFCa



Diamondback moth – adult
Alberta Agriculture and Rural Development

Hosts

Canola, mustard, and many cruciferous vegetables and weeds.

Identification

ADULTS: Small (12 mm long), very active moths with 18-20 mm wing span; when at rest, the forewings create diamond-shaped patterns along the mid line.

MATURE LARVAE: 8 mm long, narrow, green caterpillars that wriggle backwards and readily drop on a silken thread when disturbed. Terminal prolegs extend slightly backwards in a fork-like fashion.

Life Cycle

Adults are carried up on winds from the southern U.S. each spring. Establishment and number of overlapping generations (up to 3) vary from year to year depending on strength of south winds and number of migrants. Females lay their complement of 30-200 minute, disc-shaped green or yellow eggs in twos or threes on the upper and lower surfaces of leaves. Larvae pupate in a lace-like, silken cocoon on the plant. Populations die off in the fall.

Feeding Damage

ADULTS: Feed on nectar of flowers.

LARVAE: Newly hatched larvae tunnel in the leaves before exiting to feed on the leaf surfaces, creating shot holes and completely consuming leaves except the veins. Larvae will also feed on the flowers, developing pods, and strip bark from stems and pods, causing a frosted appearance in severely infested areas. Feeding damage can reduce seed quality and yield.

Similar Species

Young imported cabbageworm larvae (p. 82) have similar colouration but do not wriggle backwards or drop on a silken thread when disturbed.

Monitoring/Scouting

Pheromone traps are available to detect arrival of moths in the spring. Or consult provincial agricultural pest survey web sites for early warnings. In July and August, scout fields for signs of damage and/or larvae. Inspect 5-10 areas of the crop. At each stop, carefully pull up a plant and beat it against a smooth surface to count the dislodged larvae. Estimate the number of plants/m^2 at each stop and calculate larvae/m^2.

Economic Threshold

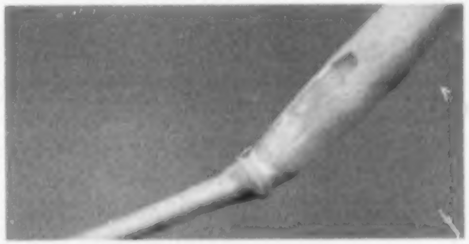
100-150 larvae/m^2 in immature and flowering canola; 200-300 larvae/m^2 (20-30/ft^2) in podded canola.

Management Options

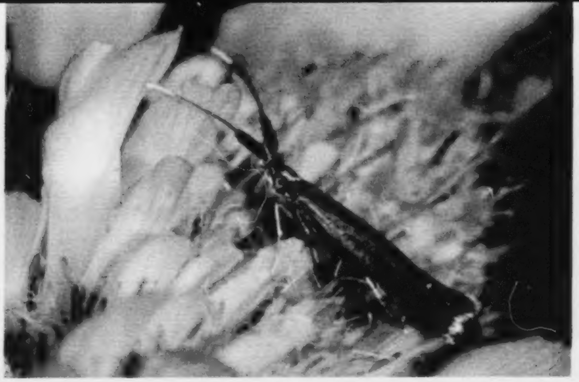
BIOLOGICAL: Four important parasitoids attack this pest: *Diadegma insulare* (Cresson), *Diadromus subtilicornis* (Gravenhorst) (Ichneumonidae) (p. 135), *Microplitis plutellae* (Haliday) (Braconidae) (p. 130), and *Trichogramma praetiosum* Riley (Trichogrammidae) (p. 138). Ground beetles (p. 115), spiders (pp. 111-114), Cotesia plutellae (Kurdjumov) (p. 130) and other generalist predators attack larvae; outbreaks of pathogenic fungi can limit or prevent population development later in the season.

CULTURAL: Control weed hosts and volunteer canola which allow sites for establishment of spring migrants.

CHEMICAL: Consult provincial recommendations for products and timing.



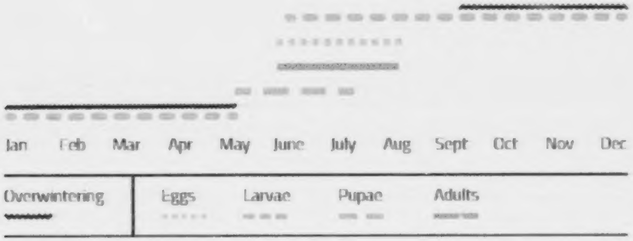
Diamondback moth – damage
Alberta Agriculture and Rural Development



Red clover casebearer moth - adult
Tim Haye

Moth, red clover casebearer

Coleophora deauratella Lienig and Zeller



Red clover casebearer moth - sealed overwintering larval cases
Boyd Mori, AAFC

Hosts

Red clover is the major host, but larvae also reportedly feed on alsike, stone, white and zig-zag clover.

Identification

ADULTS: 10-15 mm long body with metallic green forewings with a reddish sheen; wings fold over the body when at rest; 9.5-15.5 mm wingspan. Antennae are metallic green with white tips and a thickened base.

MATURE LARVAE: Contained within portable cases created from withered flower petals and silk. Cases are cigar-shaped, brown with a roughened surface and approximately 6 mm long. Larvae feed from the front end of the case; the back end is closed and has three yellow or white ridges; when disturbed, larvae withdraw their heads into their case.

Life Cycle

Overwinter as mature larvae within sealed cases on the soil surface. Pupation occurs within the case in the spring; adults emerge in early June with flight lasting until mid-August. Eggs are laid on the calyx of red clover florets. One generation per year.

Feeding Damage

ADULTS: Feed on flower nectar.

LARVAE: Larvae tunnel through the calyx and feed on developing seeds within the floret. Larvae can tunnel between adjacent florets, consuming up to three seeds per day. Cases are easily detected in mature red clover flowers.

Similar Species

No similar larvae are found infesting red clover. Both the adult banded clover casebearer (*C. mayrella* (Hübner)) and the large clover casebearer (*C. trifolii* (Curtis)) moths resemble the red clover casebearer moth; however, banded clover casebearer larvae feed only on white clover and large clover casebearer larvae feed only on sweet clover.

Monitoring/Scouting

Set out pheromone traps in late May to detect emergence of adults. At the onset of flowering and throughout the flowering period, scout the crop by opening flower heads to look for larvae and cases.

Economic Threshold

None established.

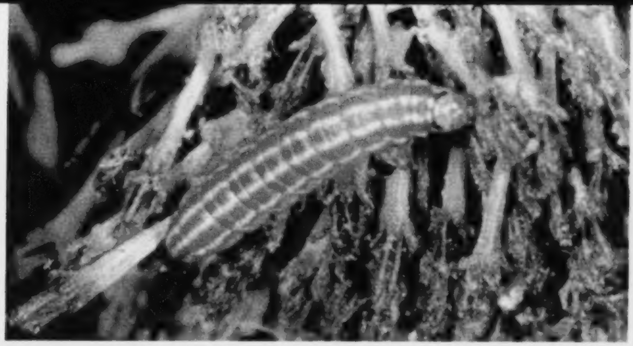
Management Options

BIOLOGICAL: Can be parasitoidized by *Gelis tenellus* (Say) (Hymenoptera: Ichneumonidae; p. 135) and several unidentified parasitoids. Ground beetles (p. 115) and spiders (pp. 111-114) may attack larvae when on the soil surface in late summer and spring.

CULTURAL: In areas with high numbers of red clover casebearer moths (e.g. Peace River Region of Alberta and British Columbia), red clover should only be grown for one year in the rotation (i.e. avoid leaving red clover stands for a second production year).

CHEMICAL: None registered in Canada.

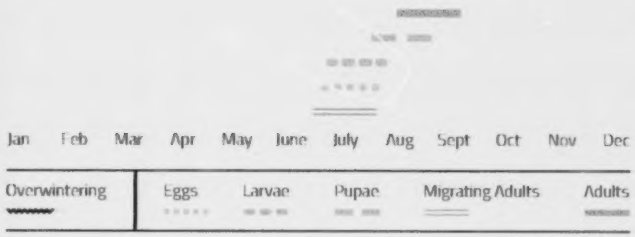
Red clover casebearer moth - larvae
Jason J. Dombroskie



Sunflower moth – caterpillar
Frank Peairs, Colorado State University, Bugwood.org

Moth, sunflower

Homoeosoma electellum (Hulst)



Hosts

Sunflower

Identification

ADULTS: Small (10-15 mm long) moths with whitish forewings which fold over their bodies when at rest; 20 mm wing span.

MATURE LARVAE: 20 mm long caterpillar with distinctive brown and pinkish-purple striping.

Life Cycle

Adults blown in from the southern U.S. lay up to 30 pearl-white eggs in pollinating blooms. Pupate in earthen cells. One larval generation per year; new adults die off in the fall.

Feeding Damage

ADULTS: Feed on nectar of flowers. Females are strongly attracted to flowering sunflowers.

LARVAE: Most infestations are limited to field margins. Newly hatched larvae initially feed on pollen and flower parts; they can destroy up to 100 florets during this period. After about a week, they tunnel deep into the heads and live within silken tubes, which retain black pellets of frass. A heavily infested sunflower head has a dark appearance.

Similar Species

Banded sunflower moth larvae (p.97) may be present.

Monitoring/Scouting

Set out pheromone traps just prior to flowering to detect arrival of adults. At the onset of blooming and through blooming, scout the crop in the evening when moths are active. Inspect 10 heads at 10 sites around the crop perimeter within 20 m of the edges and record the number of moths observed on the heads.

Economic Threshold

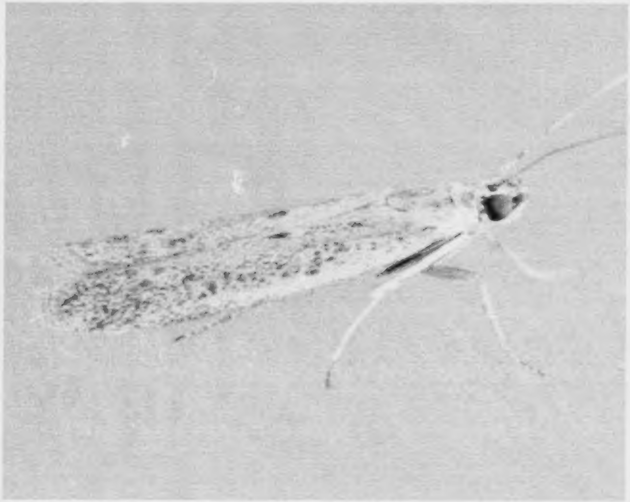
At dusk, 2-4 moths/10 heads at the onset of bloom or within seven days of the adult moth's first appearance.

Management Options

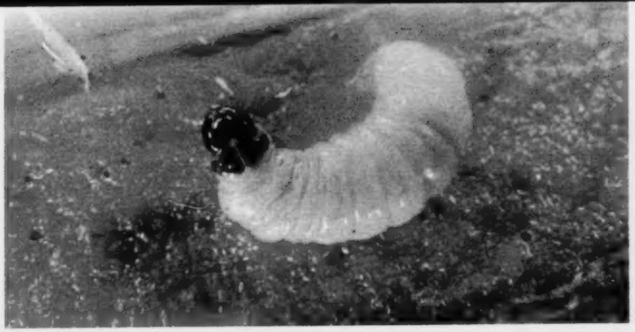
BIOLOGICAL: Spiders (pp. 111-114) will prey on adults.

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL: Apply an insecticide if the threshold is reached while the crop is in bloom to control hatching larvae.

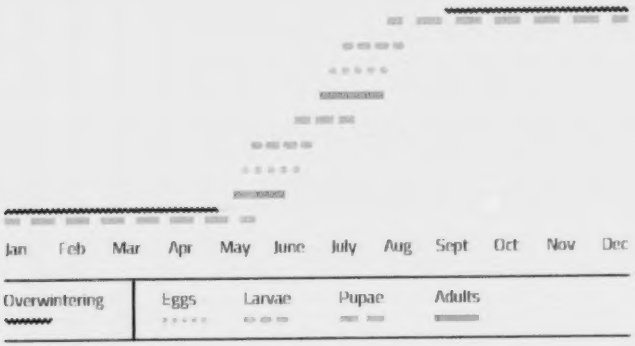


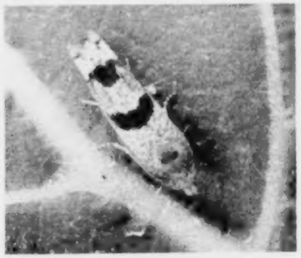
Sunflower moth – adult
Mark Dreiling, Bugwood.org



Sunflower bud moth – caterpillar
John Gavloski, Manitoba Agriculture,
Food and Rural Development

Moth, sunflower bud
Suleima helianthana (Riley)





Sunflower bud moth – adult
John Gavloski, Manitoba Agriculture,
Food and Rural Development

Sunflower bud moth – pupa
John Gavloski, Manitoba Agriculture,
Food and Rural Development

Hosts

Sunflowers

Identification

ADULTS: Small moths with gray-brown forewings with two dark transverse bands; 16-18 mm wing span. One band extends across the middle of the wing and the second band is located near the wing tip.

MATURE LARVAE: 8-10 mm long, smooth, cream-coloured caterpillars with brown heads.

Life Cycle

Overwinter as pupae in the stem of hosts. Eggs are laid on the terminals of immature sunflowers or on the receptacle of mature sunflowers. Two generations per year.

Feeding Damage

ADULTS: Feed on nectar of flowers.

LARVAE: Tunnel into stems leaving black frass over the entrance hole. Some weakening of the stem may occur but not enough to warrant concern. Larvae can also damage sunflower buds in R1 to R3 stage. Some yield loss may occur when larvae burrow into unopened buds, which prevents proper head development. Second generation larvae are not a threat.

Similar Species

None.

Monitoring/Scouting

None developed.

Economic Threshold

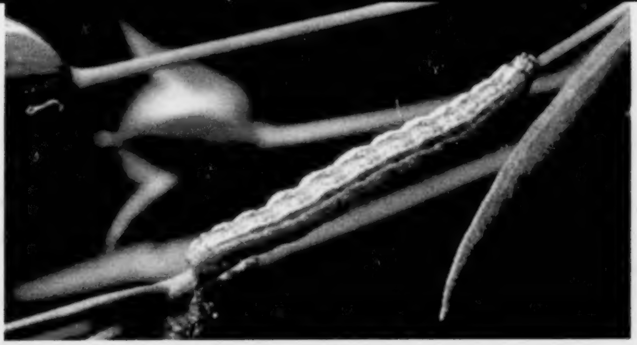
None established.

Management Options

BIOLOGICAL: Specific natural enemies are not known that can regulate pest populations.

CULTURAL: Research in North Dakota found that late planting dates (early to mid-June) of sunflowers reduced the percentage of heads damaged by sunflower bud moth compared with early planting dates.

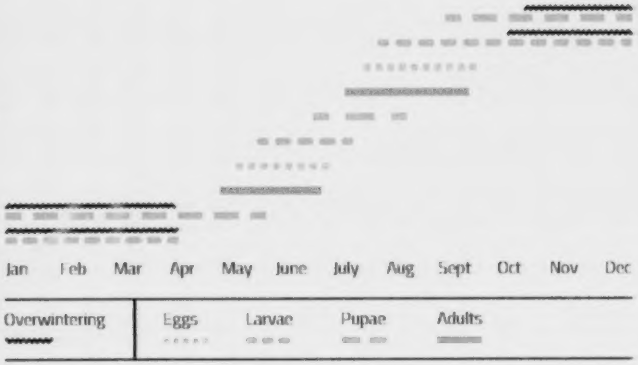
CHEMICAL: None registered in Canada.

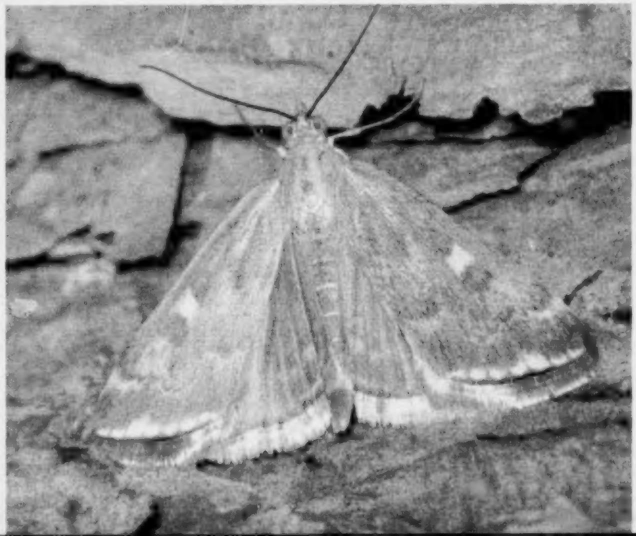


Beet webworm – caterpillar
AAFC

Webworm, beet

Loxostege sticticalis (Linnaeus)





Beet webworm – adult
Boris Loboda

Hosts

Canola, alfalfa, flax, sugar beet, sweet clover, mustard, sunflower, various vegetables, and weeds such as lamb's-quarters and Russian thistle.

Identification

ADULTS: 20 mm long, greyish-brown moths with 25 mm wing span. At rest it forms a triangular shape. Takes short erratic flight when disturbed.

MATURE LARVAE: 25-40 mm long, slender, active caterpillars with a dark green to black body with two parallel light stripes down the back, flanked by circular figures each containing a stiff hair.

Life Cycle

Overwinter as pupae or larvae within cocoons in the soil. Eggs are laid overlapping like shingles on the undersides of leaves of host plants. Eggs hatch in 7-10 days, and then larvae feed for 4-5 weeks before pupating in the soil. Two generations per year.

Feeding Damage

ADULTS: Feed on nectar from flowers.

LARVAE: Many sporadic infestations start by larvae migrating from nearby patches of weed hosts that have dried up or been destroyed. Larvae will also feed on preferred weed hosts like lamb's-quarters in crops. In canola, larvae begin feeding on leaves then move to stems and pods where they strip surface tissue, giving infested areas a frosted appearance. This stripping causes plants to desiccate prematurely, reducing seed yields. In alfalfa, larvae attack terminals, webbing leaves together. In flax, 2nd generation larvae will feed on the leaves, flowers, and bark from stems and branches.

Similar Species

Alfalfa webworm larvae (*L. cerealis* (Zeller)) resemble beet webworm larvae in appearance and size, and also feed on canola and alfalfa. The larvae of the grey tortrix (*Cnephasia stephensiana* (Doubleday)) do not resemble beet webworm larvae; however they mine leaves and later live in spun or folded leaves of alfalfa.

Monitoring/Scouting

Inspect crops in June-July for larvae, especially areas of crops with a frosted appearance. Also inspect patches of preferred weeds within crops for eggs and larvae.

Economic Threshold

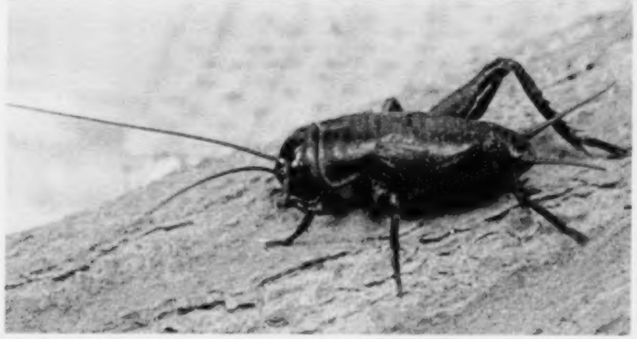
None. Threshold for bertha armyworm (p. 74) is often followed.

Management Options

BIOLOGICAL: Subject to attack by the egg parasitoid *Trichogramma praetiosum* Riley (p. 138), other parasitoids, and generalist insect predators.

CULTURAL: Normal harvesting practices will kill many larvae. Control lamb's-quarter and other weed hosts early within and adjacent to host crops to prevent build-up of potential pest populations.

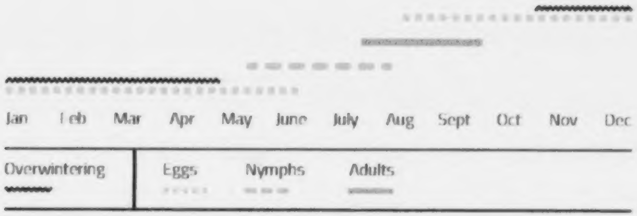
CHEMICAL: Apply as required.



Fall field cricket – adult
Joseph Berger, Bugwood.org

Cricket, fall field

Gryllus pennsylvanicus Burmeister



Hosts

Lamb's-quarters, plantain, switchgrass, crabgrass, ragweed, seeds of forages and cereals, small fruits, living insects (grasshopper eggs, pupae of moths, butterflies and flies, their own young), and dead insects.

Identification

ADULTS 15-25 mm long, with brownish forewings that do not cover the length of the shiny, dark brown to black body; two appendages (cerci) extend from the end of the abdomen; females also have an 18 mm long, sword-shaped ovipositor extending backward from the abdomen. Adults do not fly.

MATURE NYMPHS Resemble adults but smaller, lack wings and ovipositor.

Life Cycle

Overwinter eggs in clusters of around 50, laid in moist sand or soil. Nymphs can take up to 12 weeks to mature.

Feeding Damage

ADULTS AND NYMPHS Feed mostly at night. Seed yields can be reduced during outbreaks.

Similar Species

Mormon cricket (p. 104) has antennae longer than its body which is not the case with the fall field cricket.

Monitoring/Scouting

None developed.

Economic Threshold

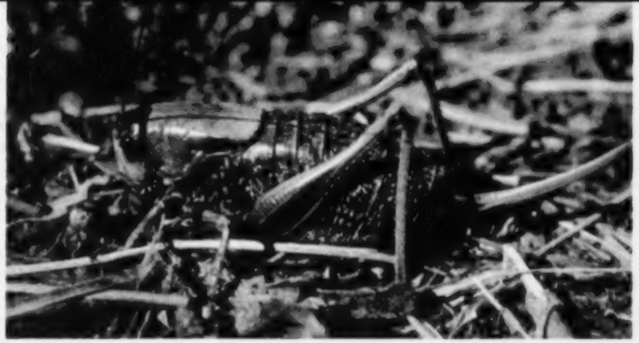
None established.

Management Options

BIOLOGICAL Several species of birds, shrews, small rodents, parasitic and predatory insects, pathogens, spiders (pp. 111-114), and toads cause high mortality among all stages.

CULTURAL Specific cultural methods have not been developed; see also IPM section (p. 3).

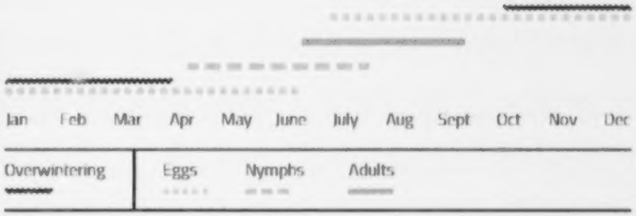
CHEMICAL None registered in Canada.



Mormon cricket – adult
Howard Ensign Evans, Colorado State University, Bugwood.org

Cricket, Mormon

Anabrus simplex Haldeman



Hosts

Forbs (broad-leafed plants) are favoured, but grasses and shrubs such as sagebrush are also eaten. Field crop hosts include wheat, barley, alfalfa, sweetclover, as well as forages and garden vegetables (estimated 400 hosts). They also eat insects, including other Mormon crickets.

Identification

ADULTS: 40–50 mm long, stout-bodies; colour varies according to population density – swarming individuals may be black, brown, or red, whereas solitary individuals are purple or green. The "shield" (pronotum) behind the head may have colored markings. The abdomen may appear to be striped. Females have a long ovipositor. Both sexes have antennae longer than the body and neither can fly.

MATURE NYMPHS: Resemble adults in appearance and colour variation except for smaller size and lack of ovipositor in females.

Life Cycle

Overwinter as eggs laid singly in disturbed soil and hatch the following spring when the soil temperature reaches 4.5°C. One generation per year.

Feeding Damage

ADULTS AND NYMPHS: Migrating swarms will feed on all parts of plant hosts, devastating crops and significantly reducing marketable yields. Alfalfa baled with crickets is unpalatable to livestock. Drought encourages Mormon cricket outbreaks, which may last several years (historically 5 to 21 years).

Similar Species

Fall field cricket (p. 103) may be present in some crops. Its antennae are not as long as its body. There are other *Anabrus* species; however they never reach outbreak densities.

Monitoring/Scouting

Starting from a corner of the field, sample at least twenty sites along a line to the field centre, then to one side. Count the number of nymphs that jump in a 1 ft^2 area as you approach each site (e.g. every 100 steps). Divide the total number of grasshoppers counted by 2 for number/m^2.

Economic Threshold

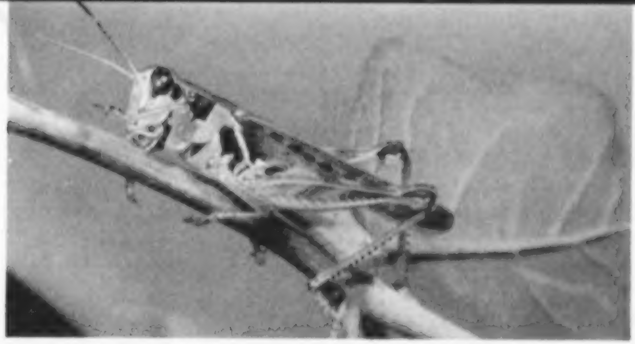
No specific thresholds for this pest; however, thresholds for grasshoppers may be useful guides depending on location. Thresholds are posted on the Western Committee on Crop Pests web site by crop at www.westernforum.org/WCCP%20 Guidelines.html.

Management Options

BIOLOGICAL: Birds, small rodents, coyotes, and parasitic and predatory insects are the primary natural enemies.

CULTURAL: Shallow fall cultivation will expose eggs to predation.

CHEMICAL: Bait and spray products are available to treat areas where damage and numbers justify protection.



Migratory grasshopper – adult
Joseph Berger, Bugwood.org

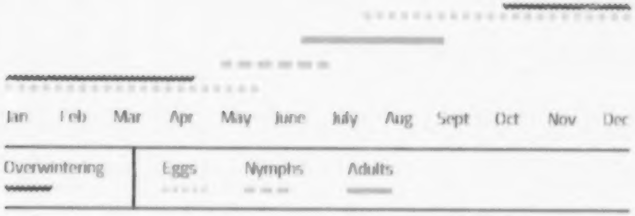
Grasshoppers

Packard
Melanoplus packardii Scudder

clearwinged
Camnula pellucida Scudder

migratory
Melanoplus sanguinipes (Fabricius)

two-striped
Melanoplus bivittatus (Say)



Hosts

Forage legumes and grasses, pulses, oilseeds, cereals, corn, vegetables, native grasses, and forbs; will also attack shrubs and trees when green plants not available.

Identification:

Packard grasshopper

ADULTS: 27-32 mm long, gray to dark yellow body; two light coloured stripes extend from just behind the eyes to the end of the thorax. The forewings are uniformly grey and lack distinctive stripes. The last two segments of the hind legs are blue-green.

NYMPHS: First instar is pale green to yellow-brown in colour, speckled with numerous small dark spots.

Clearwinged grasshopper

ADULTS: 21-32 mm long, body yellowish to brownish; wings are clear but mottled with dark patches; two stripes beginning at the thorax and converging at the tip of the forewings.

NYMPHS: Newly hatched young are black with a distinctive white band encircling the thorax.

Migratory grasshopper

ADULTS: 23-28 mm long, body brownish to grayish, with a small black stripe across the head; hind legs are marked with a series of black bands.

NYMPHS: mottled grayish body with stripe across head.

Two-striped grasshopper

ADULTS: 26-40 mm long, brownish or greenish with black or brown markings and two pale stripes extending back from the eyes to the tip of the forewings. Each hind leg has a solid longitudinal black stripe.

NYMPHS: Newly hatched are tan, then change to brown or light green as they mature; two diffuse stripes down the thorax.

Life Cycle

Overwinter as eggs in pods (8-150 eggs/pod) laid in soil and hatch the following spring when the temperature reaches 4.5°C. One generation per year.

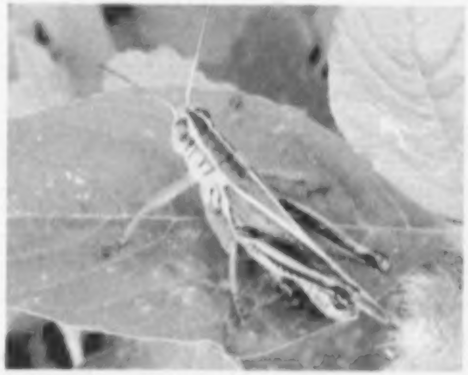
Feeding Damage (Adults and Nymphs)

PACKARD GRASSHOPPER: Prefers light textured soils with scanty grass cover; similar food hosts to migratory grasshopper.

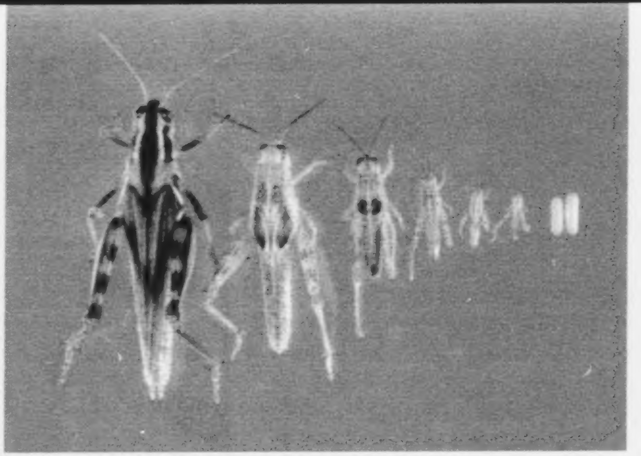
CLEARWINGED GRASSHOPPER: Prefers cereal grains and some of the more succulent cultivated grasses, seldom feeding on broad-leaf plants.

MIGRATORY GRASSHOPPER: Weedy grain fields, cultivated pastures, and hay fields; preferred foods include dandelion, tumble mustard, wild mustard, pepperweed, western ragweed, downy brome, Kentucky bluegrass, barley, and wheat. Will clip pods and heads to feed on green tissue as crops mature.

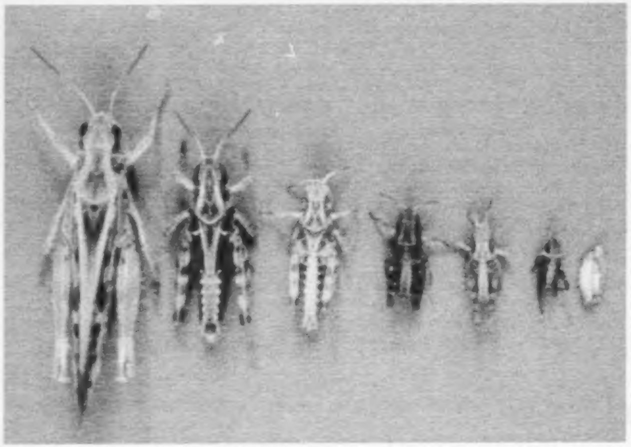
TWO-STRIPED GRASSHOPPER: Prefers moist areas of lush vegetation, meadows; wide host range including broad-leaf crops (alfalfa, pulses), cereals, and grasses.



Two-striped grasshopper – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development



Packard grasshopper – egg, nymph, adult
AAFC



Clearwinged grasshopper – egg, nymph, adult
AAFC

Similar Species

There are many other species of grasshoppers present in varying numbers from year to year that do little if any economic harm to field crops.

Monitoring/Scouting

Starting from a corner of the field, sample at least twenty sites along a line to the field centre, then to one side. Count the number of nymphs that jump in a 1 ft^2 area as you approach each site (e.g. every 100 steps). Divide the total number of grasshoppers counted by 2 for number/m^2. Check field margins for grasshoppers moving in from roadsides and headland. Also check around wet areas in drought seasons.

Economic Threshold

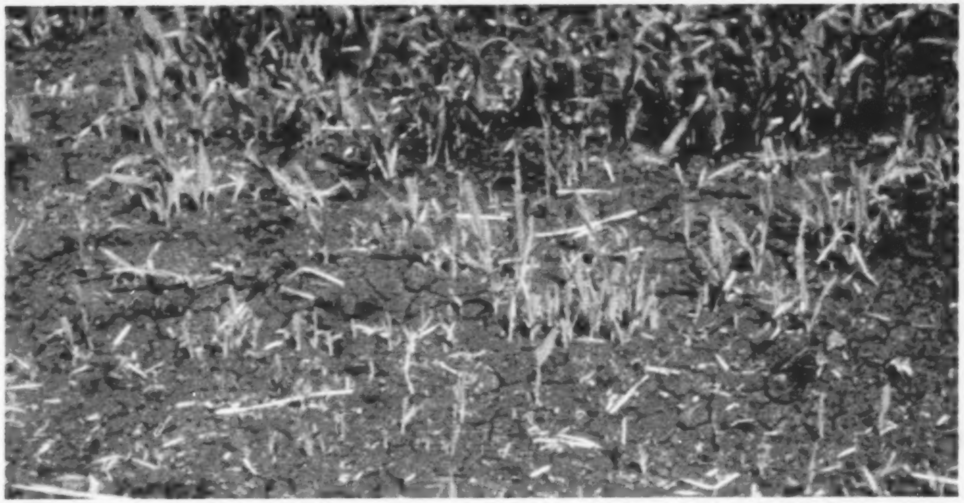
Thresholds are posted on the Western Committee on Crop Pests web site, by crop, at www.westernforum.org/WCCP%20Guidelines.html.

Management Options

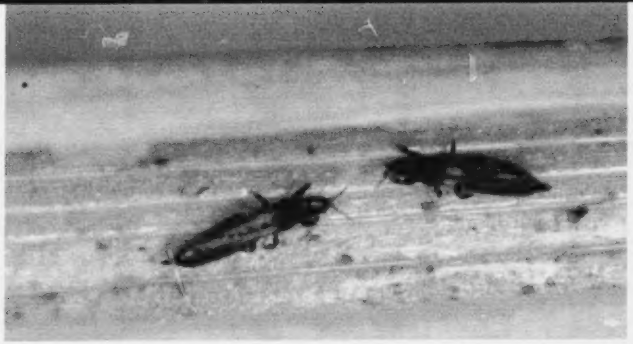
BIOLOGICAL: Birds, small rodents, coyotes, parasitic and predatory insects, as well as the pathogenic fungus *Entomophthora grylli* Fresenius, and the microsporidian parasite *Nosema locustae* Canning.

CULTURAL: Consult provincial agriculture web sites for information on recommended practices including earlier seeding, tillage and chemical fallow, and trap strips that can help to delay or reduce the impact of grasshopper infestations.

CHEMICAL: Several products are available as sprays and baits. Treat only if damage and numbers warrant. Target younger instars in order to use the lowest recommended rates and to reduce the area requiring treatment. Grasshoppers present prior to May are not a threat to field crops. Once grasshoppers reach adult stage, insecticides are much less effective in protecting crops.



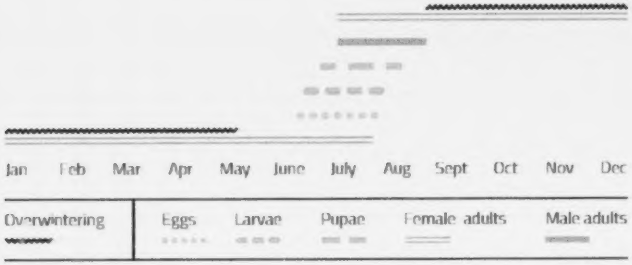
Two-striped grasshopper – damage
AAFC

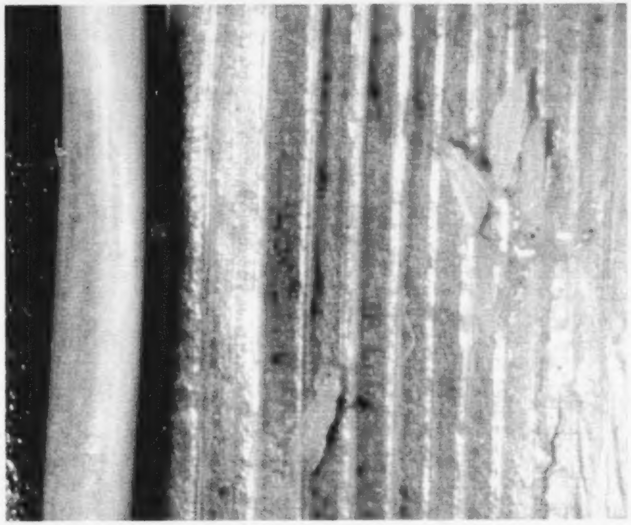


Barley thrips – adult
Mike Dolinski, MikeDolinski@hotmail.com

Thrips, barley

Limothrips denticornis Haliday





Barley thrips – larvae
Mike Dolinski, MikeDolinski@hotmail.com

Hosts

LARVAL HOSTS: Barley.

ADULT HOSTS: Oats, winter wheat or rye, spring and durum wheat, Kentucky bluegrass, and brome grasses.

Identification

ADULTS: 1.1–1.8 mm long, very narrow dark brown to black body. Narrow forewings are fringed with long hairs; males are wingless.

MATURE LARVAE: 0.25–1.8 mm narrow, white to pale yellowish-green body with red eye spots; wingless.

Life Cycle

Overwinter as mated females in grass hosts and other protected sites near or under shelterbelts. Some may blow in from the U.S. each spring. New females leave ripened crops for overwintering sites; remaining males and immatures die off. Only one generation per year but active throughout the summer.

Feeding Damage

ADULTS AND LARVAE: Feed by puncturing plant cells and sucking out the contents causing plant tissue to turn white or distort. Under severe pressure heads turn white ("white heads") and stems and heads have twisted, gooseneck shape. Intensive feeding at the beginning of head formation produces small, shriveled grains. Often there is no seed development at the top and bottom of the head and intermediate grains are shriveled. When thrips feeding is severe on the flag leaf, kernels do not fill properly and seed weight is reduced.

Similar Species

Barley thrips can be distinguished from other species by an angular projection on the 3rd antennal segment. Feeding causes "white heads" similar to that caused by other agents.

Monitoring/Scouting

Sampling should begin when the flag leaf is first visible and continue until the head is completely emerged from the boot. A sequential sampling plan has been developed for barley. Adult barley thrips are counted on the top 2 leaf sheaths on a minimum of 9 plants. Unroll the leaf sheath away from the stem to find the thrips.

Economic Threshold

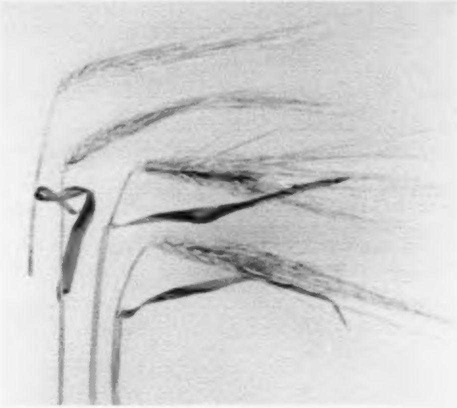
Barley, 7–8 thrips/stem prior to head emergence. Or use the calculation cost of control (chemical + application ÷ expected value of crop at harvest ÷ 0.4). Compare value to average number of thrips/stem.

Management Options

BIOLOGICAL: The predaceous thrips, *Aeolothrips fasciatus* Linnaeus, and other beneficial insects and mites such as minute pirate bugs (p. 128), green lacewings (p. 139), and predaceous mites (p. 110).

CULTURAL: Specific cultural methods have not been developed; see also IPM section (p. 3).

CHEMICAL: Apply recommended control products before heading is complete if and when thrips pressure warrants control.

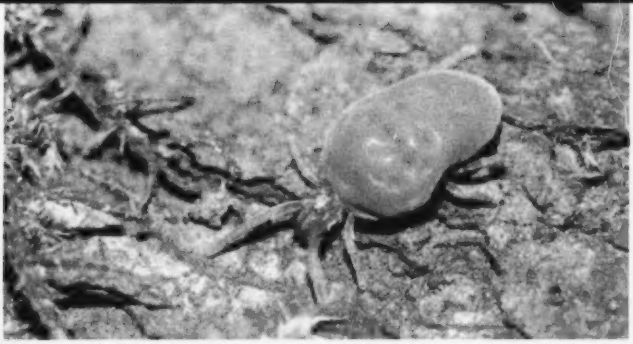


Barley thrips – damage
AAFC

Bee Fly
Tyler Wist, AAFC

DESCRIPTIONS OF NATURAL ENEMIES

Ladybird beetle larva eating aphids
Mike Dolinski, MikeDolinski@hotmail.com



Red velvet mite – adult
(*Trombidium holosericeum*)
Jörg Hempel, Wikimedia Commons

Mites, predatory

whirligig
Anystis spp.

red velvet
Trombidium holosericeum (Linnaeus)

Hosts/Prey

Spider mites, insect eggs and small insects such as thrips (p. 107), young aphids (pp. 59-70), and leafhoppers (pp. 45-47).

Identification

ADULTS Whirligig adults are <1.0 mm long with reddish brown triangular shaped bodies and 8 relatively long legs.

Red velvet mites are very large for a mite, about 4 mm long, with bright red velvety body and short legs. The body is flattened and the abdomen is somewhat constricted across the middle and has several indentations.

NYMPHS Resemble adults except smaller.

Life Cycle

These mites overwinter as adults in the soil (red velvet mites) or under soil debris and under tree bark (whirligig mites). Females lay their eggs in the same habitats. Newly hatched nymphs immediately disperse in search of prey. There are several generations per year.

Similar Species

Whirligig mites resemble the predaceous mite, *Balaustium putnami* Smiley, which has a more elongate red velvety body and a distinct gap between the 2nd and 3rd pair of legs. Red velvet mites are often mistaken as small spiders because of their size.

Monitoring

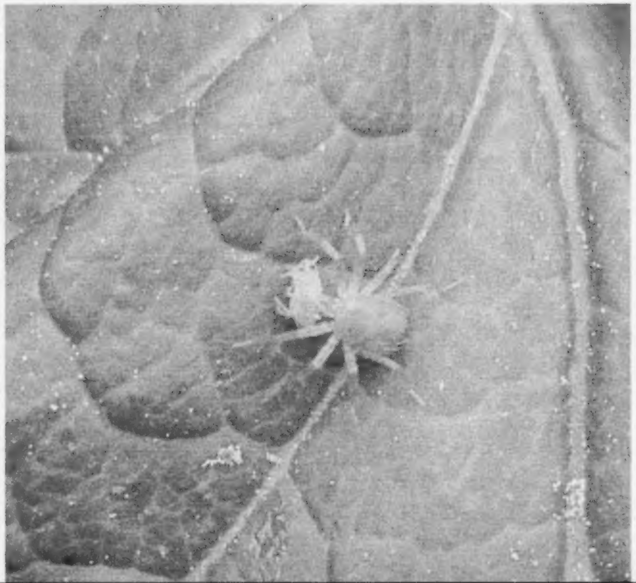
Collect mite-infested plant parts and beat them against a light-coloured surface coated with a thin film of liquid soap or light oil to immobilize the mites. Use a hand lens to examine the dislodged insects and mites for any predatory mites.

Conservation

Preserve unsprayed vegetation near fields where adults can feed on pollen, find prey and reproduce. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

Comments

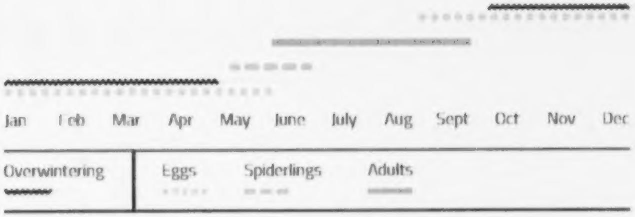
Whirligig mites are abundant and diverse inhabitants of leaf litter, moss, the upper layers of soil, and foliage. They get their name from the way they follow a spiral path when searching for prey. Once captured, the mites suck out the body fluids. Newly hatched red velvet mites attach to large insects and spiders and suck up body fluids. Adults and nymphs are free-living. Whirligig mites spend most time on vegetation and trees whereas red velvet mites prefer searching the soil surface and under debris for prey.



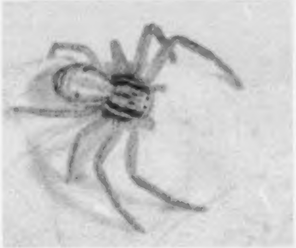
Whirligig mite – adult (*Anystis* sp.)
Aleksandr Balodis (AfroBrazilian), Wikimedia Commons

Goldenrod crab spider – adult
(*Misumena vatia*)
Don Buckle, Saskatoon, SK

Spiders, crab



Goldenrod crab spider – adult
(*Misumena vatia*)
Don Buckle, Saskatoon, SK



Ground crab spider – adult
(*Xysticus luctans*)
Don Buckle, Saskatoon, SK

Yellow crab spider – adult
Tyler Wist, AAFC

Hosts/Prey

Any insects visiting flowers, both harmful and beneficial (small flies, ants, bees and wasps, beetles, small moths, thrips).

Identification

ADULTS: 5–11mm long, flattened, either round or elongate body; variously coloured (bright to dull), often to blend in with background (common species appear white, yellow or green and sometimes have two very faint red bands that run along their abdomen); first two pairs of legs are larger than rear two pair; eight eyes on raised bumps in two backward curved rows of four eyes each.

Life Cycle

Overwinters as eggs which are enclosed in a silken sac or attached to leaves or twigs, depending on species. Adults live less than a year. One generation per year.

Similar Species

None.

Monitoring

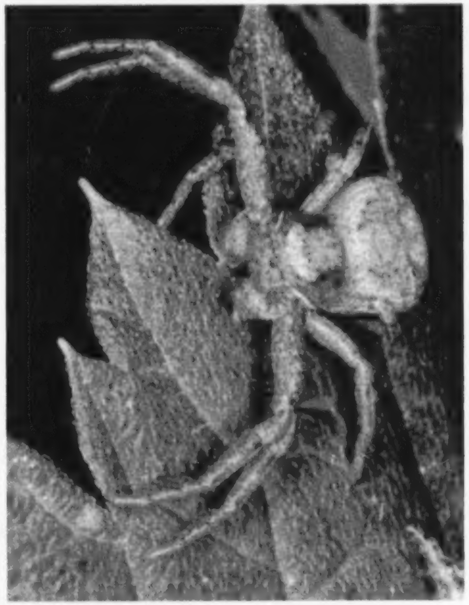
Use sweep net, pitfall or pan traps to capture adults.

Conservation

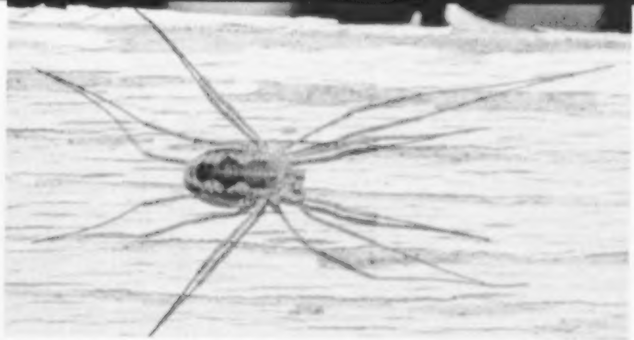
Avoid applying pesticides toxic to spiders when present. Preserve flowering vegetation near fields as a refuge for spiders which will spread into nearby crops in search of prey.

Comments

Hunt by ambushing flower-visiting insects, holding their front pairs of legs open to capture unsuspecting prey. Prey is bitten by fangs, raised overhead and digested contents are ingested. Some will actively hunt insect prey on the ground and vegetation (2nd pair of legs is the largest). They walk sideways in a crab-like fashion.

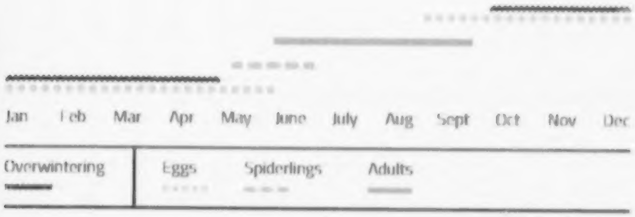


Crab spider – adult
Mike Dolinski, MikeDolinski@hotmail.com



Common harvestman spider – adult
(*Phalangium opilio*)
Don Buckle, Saskatoon, SK

Spider, harvestman
(a.k.a. daddy-long-legs)



Hosts/Prey

Spiders, flies (pp. 35-44), aphids (pp. 59-70), leafhoppers (pp. 45 -47), snails, earthworms, dead animals, bird droppings, fungi, and decaying plant matter.

Identification

ADULTS: 4–8 mm long, oval to round body with characteristic 4 pair very long slender legs. The second pair of legs are longer than the others and function as antennae; only one pair of eyes in the centre of the head on a small knob.

Life Cycle

Overwinters as eggs laid in the ground. Adults can live 1–2 years. Females lay only one batch of eggs.

Similar Species

None.

Monitoring

Use pitfall or pan traps to capture adults.

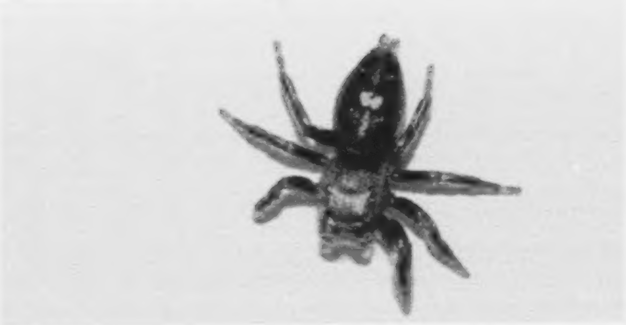
Conservation

Avoid applying pesticides toxic to harvestmen when present. Preserve pesticide-free areas near fields as a refuge for harvestmen which will spread into nearby crops in search of prey.

Comments

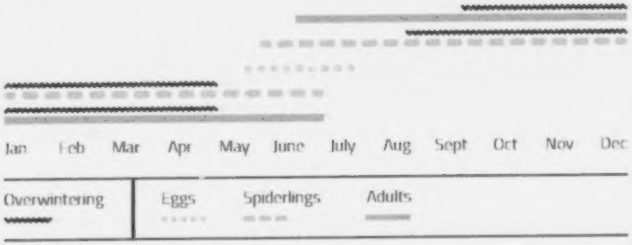
Harvestmen are not true spiders. Mainly hunt at night by ambushing prey. They lack poison glands, and as a result chew up its prey rather than suck up digested body contents. It also lacks silk glands. Harvestmen release a foul-smelling odor as a defense against predators.

Common harvestman spider – adult
(*Phalangium opilio*)
Don Buckle, Saskatoon, SK



Jumping spider – adult
(*Phidippus* sp.)
Don Buckle, Saskatoon, SK

Spiders, jumping



Hosts/Prey

Small insects and spiders.

Identification

ADULTS: 3–15 mm long, fuzzy bodies often brightly coloured with shiny scales, with different coloured markings (white, red, black) in various patterns; hind pair of legs slightly modified for jumping. Four pair of eyes arranged in 3 rows. The first row of eyes has four eyes. Two large median eyes and two smaller lateral eyes supplement the first row. The second row contains two very small eyes, and the third row has two small eyes.

Life Cycle

Overwinter in sheltered locations as adult mated females or nearly mature spiderlings. Many females construct a silk case for their single batch of eggs and guard them until they hatch. Only one generation per year; most adults live 1 year but some live up to 3 years.

Similar Species

No other spiders jump to capture prey or escape predation. They are one of the most colourful spiders.

Monitoring

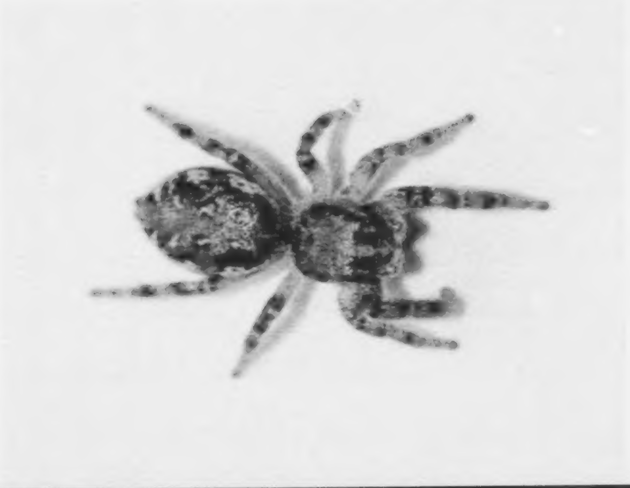
Use sweep net, pitfall, or pan traps to capture adults.

Conservation

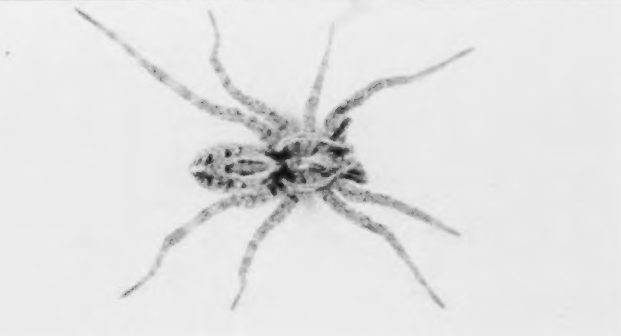
Avoid applying pesticides toxic to spiders when present. Preserve vegetation near fields as a refuge for spiders which will spread into nearby crops in search of prey.

Comments

They are very good jumpers, leaping from perches trailing a silk thread to capture prey in their front legs. Use their very keen eye sight to hunt during the day on the ground, on ground debris, or up plants. Like other spiders they have fangs with which to inject toxic venom to immobilize and digest the prey before consuming.

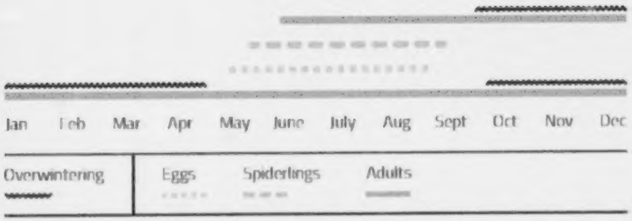


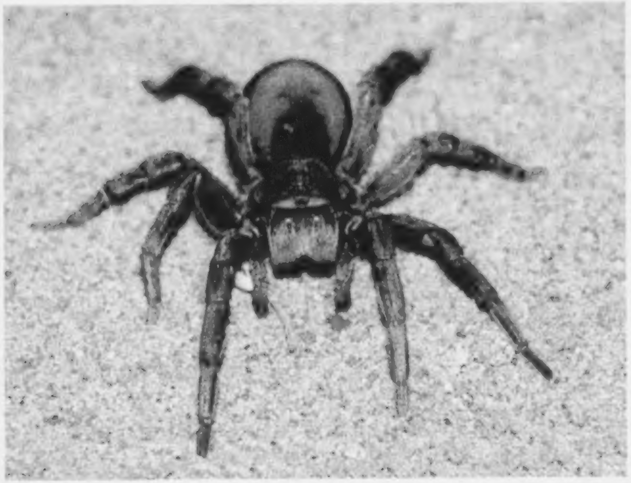
Jumping spider – adult
(*Pelegrina flavipedes*)
Don Buckle, Saskatoon, SK



Wolf spider – adult
(*Schizocosa cespitum*)
Don Buckle, Saskatoon, SK

Spiders, wolf





Wolf spider – adult
(*Geolycosa missouriensis*)
Don Buckle, Saskatoon, SK

Hosts/Prey

Any insects they can chase down on the ground or plants—aphids (pp. 59-70), springtails, leafhoppers (pp. 45-47), flies (pp. 35-44), grasshoppers (p. 105), crickets (pp. 103-104), and beetles (pp. 17-23).

Identification

ADULTS: 3-35 mm long, hairy, brown to gray body with various markings or lines; 4 pair of moderately long hairy legs. Their eyes comprise 3 rows; the first row has 4 small eyes; the second row has 2 larger eyes and the third row has 2 medium-sized eyes.

Life Cycle

Overwinter as adults in dwellings, under rocks and other protected sites. Females of some can live for several years. Females produce several batches of eggs each season depending on food supply.

Similar Species

Resemble other species of brown ground-dwelling spiders which are all beneficial.

Monitoring

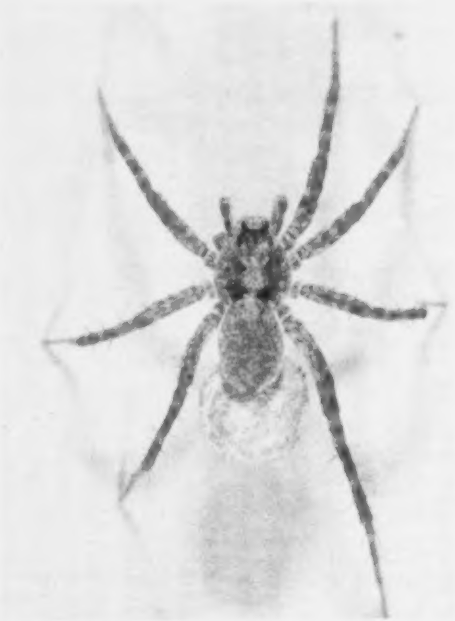
Use pit fall or pan traps to capture adults.

Conservation

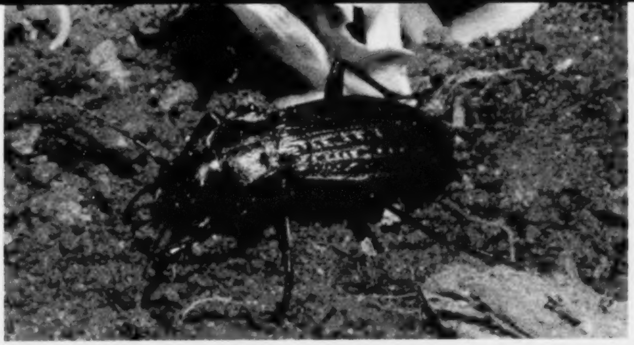
Avoid applying pesticides toxic to spiders when present. Preserve vegetation near fields as a refuge for spiders which will spread into nearby crops in search of prey.

Comments

Some species burrow under rocks or in the soil to rest. Use their very keen eyesight to hunt on the ground, over rocks, wood debris, or up plants. Female drags her egg sack (resembles a white cocoon) around until spiderlings hatch which are then carried on her back until they can fend for themselves. Wolf spiders are shy and seek to run away when disturbed. Common invaders of dwellings in the fall.

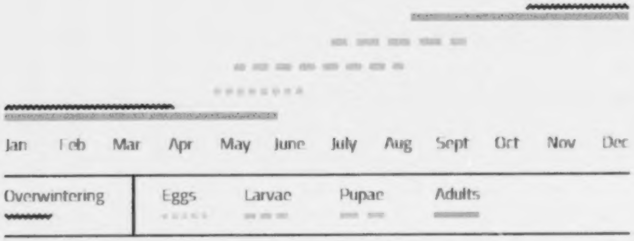


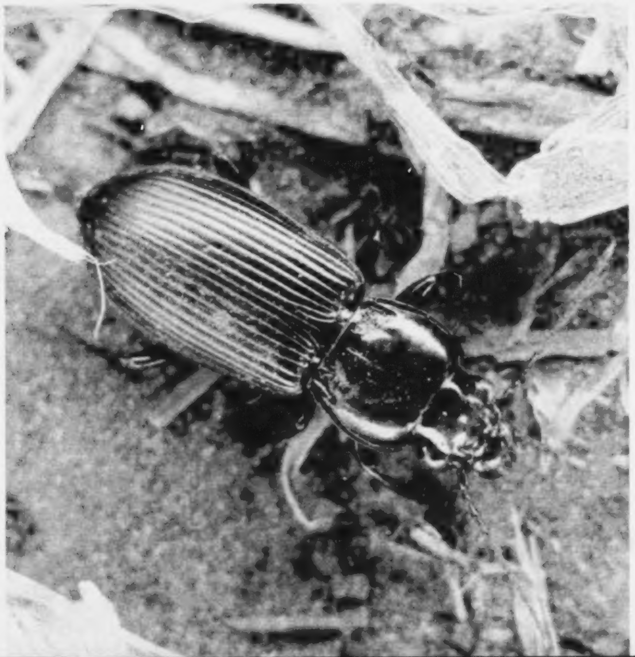
Wolf spider – adult
(*Pardosa tesquorum*)
Don Buckle, Saskatoon, SK



Ground beetle – adult
Mike Dolinski, MikeDolinski@hotmail.com

Beetles, ground
(various species)





Ground beetle – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development

Hosts/Prey

ADULTS: Any immature or adult stages of insects they can capture; also earthworms, slugs, and snails.

LARVAE: Tree and soil-dwelling soft-bodied insect stages, earthworms, slugs, and snails.

Identification

ADULTS: 2-38 mm long, somewhat flattened dark brown or black shiny bodies; some are metallic blue or green; chewing mouthparts often projected forward; slender legs for running.

MATURE LARVAE: 2–40 mm long, elongate, flattened, smooth, dark-coloured free-living; tapered end or two small projections; large head and prominent pincher-like mouthparts.

Life Cycle

Most species overwinter as adults in protected sites in and around fields. Females lay eggs in the soil. Pupation occurs in soil cells. Usually one generation per year but some may have up to three.

Similar Species

Click beetles (adult wireworms) (p. 33), yellow mealworm (*Tenebrio molitor* Linnaeus), and tiger beetles, although the latter are usually more patterned and move faster.

Monitoring

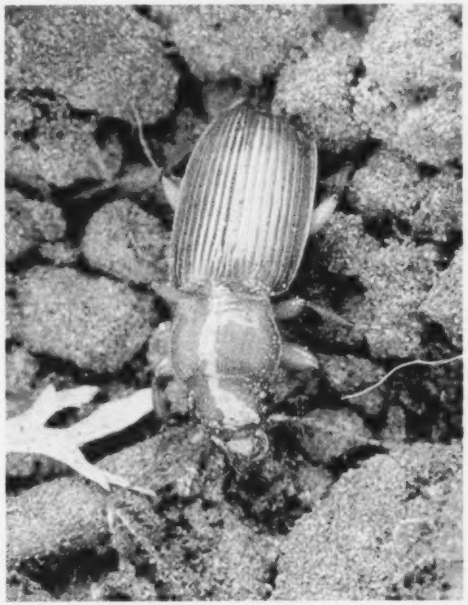
Use pitfall traps to detect adults. Sift soil or look under soil debris (stones, boards, mulch) to find larvae.

Conservation

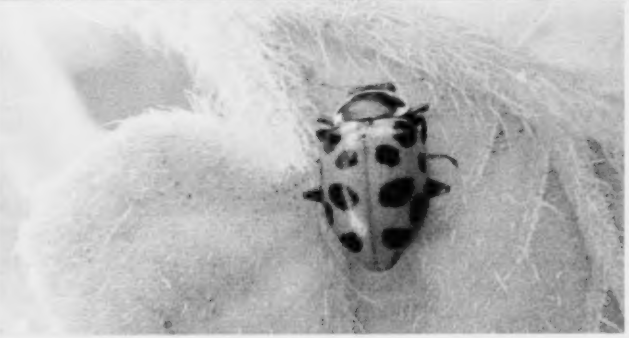
Minimizing tillage and avoiding use of toxic pesticides helps protect populations.

Comments

Commonly found under leaves or debris, in cracks in the soil, or running along the ground. Hunts mostly at night. Some species also climb into trees, shrubs, and crop plants looking for prey. In general, arable land contains more ground beetles than does land planted to permanent crops such as clover or alfalfa.



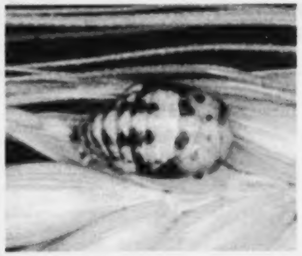
Ground beetle – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development



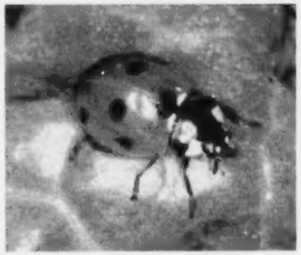
Thirteen-spotted ladybird beetle – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development

Beetles, ladybird

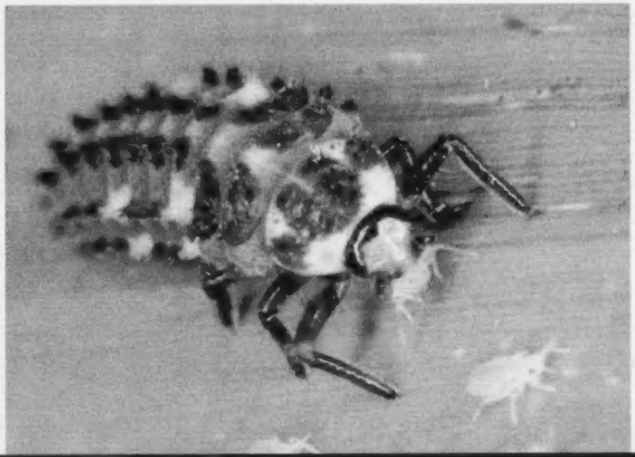
Adalia spp./*Coccinella* spp.
Harmonia spp./*Hippodamia* spp.
(a.k.a. ladybugs, lady beetles)



Ladybird beetle – pupa
Mike Dolinski, MikeDolinski@hotmail.com



Seven-spotted ladybird beetle – adult
Mike Dolinski, MikeDolinski@hotmail.com



Ladybird beetle larva eating aphids
Mike Dolinski, MikeDolinski@hotmail.com

Hosts/Prey

Aphids (pp. 59-70), mites (pp. 14-16), scale insects, mealybugs (p. 71), thrips (p. 107); other soft-bodied insects, and insect eggs when preferred food is scarce.

Identification

ADULTS 1-7 mm long, oval, elytra black, orange, red; with or without red or black spots, depending on species.

EGGS Yellow to orange, 0.5-1.5 mm long, elongate, laid upright in clusters of 3–300 on host-infested plant parts.

MATURE LARVAE Up to 11 mm long with six thoracic legs, slate-blue body with various patterns of yellow or orange markings on abdomen, depending on species; fast moving, usually found in aphid colonies or wandering in search of same.

Life Cycle

Overwinter as adults outside fields in protected locations, frequently in large groups. Adults emerge in spring and search for host colonies by which to lay eggs. Larvae present mid-May to early July, then pupate on leaves; 1-3 generations/year depending on species. New adults feed until moving to overwintering sites.

Similar Species

None.

Monitoring

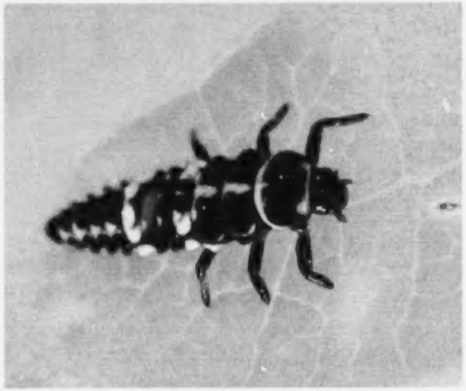
Visual inspection of plants or use sweep net to detect adults and larvae. Examine leaves for eggs and pupae.

Conservation

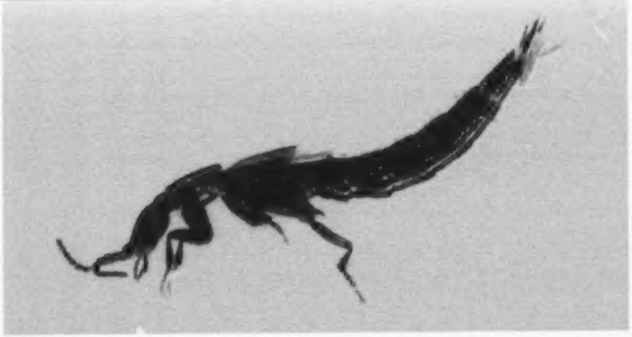
Avoid applying pesticides toxic to adults and larvae when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

Comments

Most species have consistent number of spots which is often reflected in the species name (e.g. sevenspotted lady beetle, *Coccinella septempunctata* Linnaeus; twospotted lady beetle, *Adalia bipunctata* (Linnaeus)). However the recent immigrant and aggressive predator, the multi-coloured Asian lady beetle (*Harmonia axyridis* (Pallas)), can vary from solid black or red, and have various numbers of black or red spots.

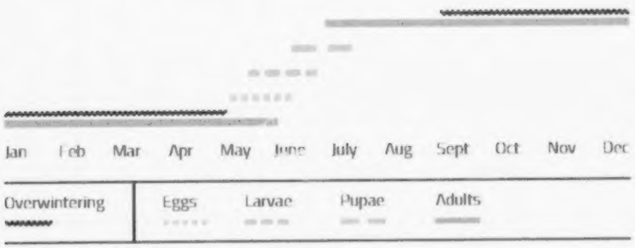


Thirteen-spotted ladybird beetle – larva
John Gavloski, Manitoba Agriculture, Food and Rural Development



Rove beetle – adult
Tyler Wist, AAFC

Beetles, rove



Hosts/Prey

ADULTS: Aphids (pp. 59-70), mites (pp. 14-16), eggs, and larvae of many insects present under plant debris, rocks, stones, carrion, dung, and other materials.

LARVAE: Same as adults; larvae of *Aleochara* spp. parasitize the larvae of various species of flies (e.g. root maggots).

Identification

ADULTS: 4-25 mm long, generally elongate, brown or black body; characterized by short forewings that do not cover the abdomen but conceal well-developed transparent hindwings; chewing mouthparts. Vary greatly in size, shape, and colours.

MATURE LARVAE: Elongate, cylindrical but slightly flattened, off-white with brownish head and prominent legs; most species have two slender projections on the tip of the abdomen; each projection is about the length of two abdominal segments or slightly longer.

Life Cycle

Adults overwinter in protected sites. Females lay eggs near larval food sources. Pupation occurs in soil litter or moist soil. One or two generations per year depending on species.

Similar Species

Some species resemble the European earwig but lack the pincer-like posterior appendages and size.

Monitoring

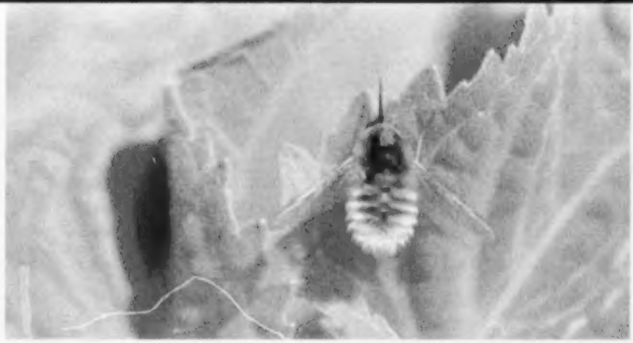
Install pitfall traps or look under plant and other soil debris for adults and larvae.

Conservation

Minimizing tillage and avoiding use of toxic pesticides helps protect populations.

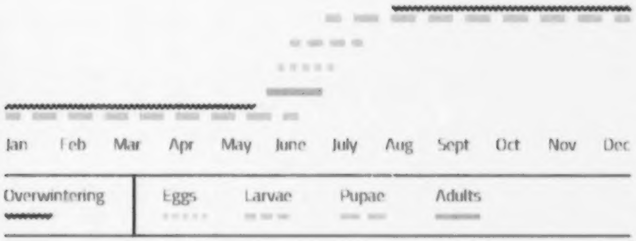
Comments

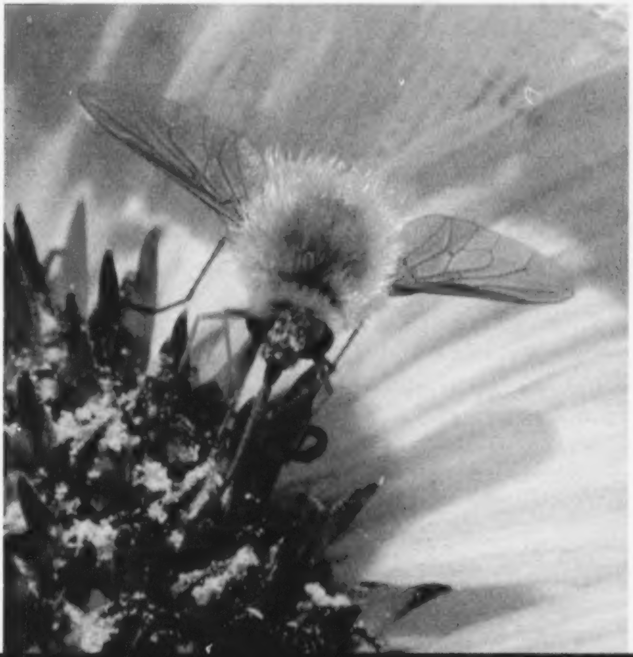
Adults are mostly nocturnal hunters, good fliers, can run fast and will raise the end of their abdomen when disturbed.



Bee fly – adult
Mike Dolinski, MikeDolinski@hotmail.com

Flies, bee





Bee fly – adult
Tyler Wist, AAFC

Hosts/Prey

ADULTS: Feed on nectar and pollen, honeydew and sap.

LARVAE: Either parasitoids of soil inhabiting immature stages of moths, flies, beetles, wasps, and bees, or prey on grasshopper eggs (e.g. *Systoechus oreas* Osten Sacken).

Identification

ADULTS: 2-28 mm long, stout, hairy body with long, slender legs, and a prominent forward pointing slender "beak"; brown, red, or yellow with bright markings. Transparent wings may have dark bands or marks, and hold their wings at a characteristic "swept back" angle or straight out at rest.

MATURE LARVAE: 9-22 mm long, whitish, crescent-shaped, tapered towards the head with ring-like segments and slender sickle-shaped mouthparts.

Life Cycle

Adults favour sunny conditions and dry, often sandy, or rocky areas. Females usually deposit eggs in sand or dust which may also coat the eggs.

Similar Species

Adults resemble syrphid (hover) fly adults (p. 122) except their body is much hairier. The long sucking mouthparts allow bee flies to hover over flowers when feeding unlike syrphids which must land to feed on nectar and pollen.

Scouting

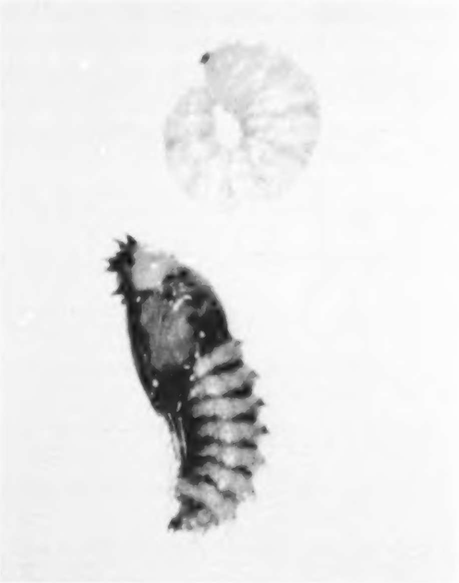
Observe flowering plants for hovering adults or use sweep net to collect adults.

Conservation

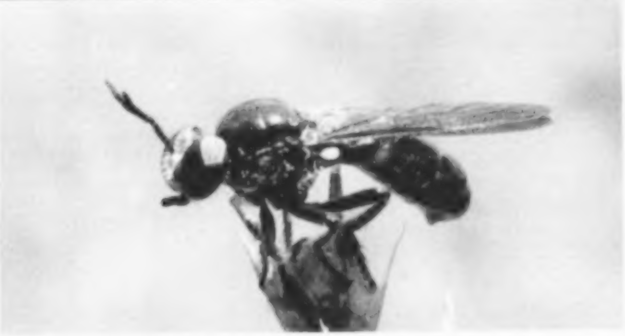
Avoid applying pesticides toxic to adults and larvae when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

Comments

Adults are important pollinators, and fast fliers capable of hovering. Larvae of some species can be a problem in bee hives.

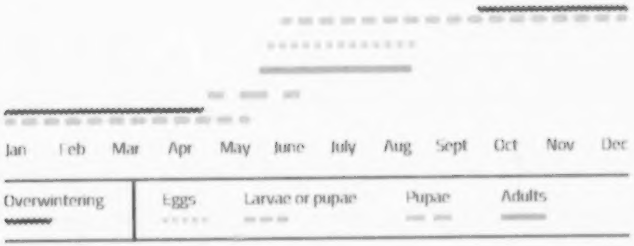


Bee fly – larva
AAFC



Robber fly – adult (*Cerotainia macrocera*)
Pascal Hedell, Flickr

Flies, robber



Hosts/Prey

ADULTS: Wasps and flies main prey; also feed on dragonflies, grasshoppers, moths, and other insects they can capture in flight or pounce on.

LARVAE: Soil-inhabiting stages of many insects.

Identification

ADULTS: 8-14 mm long, brownish to black body with yellow or reddish-orange marks; characteristic beard-like bristles on face above short, stout piercing and sucking mouthparts; bulging eyes on either side of sunken forehead; tapered elongate abdomen; with or without body bristles; stout, spiny legs adapted for grasping and feeding on prey in flight; transparent wings may have markings.

MATURE LARVAE: 8-15 mm long, elongate, cylindrical, and whitish to cream coloured free-living larvae; body tapered at both ends, small distinct head.

Life Cycle

Overwinter as larvae or pupae in the soil. Females lay whitish-colored eggs on low-lying plants and grasses, or in crevices within soil, bark, or wood. Takes 1-3 years to complete depending on species and location. One generation per year.

Similar Species

Damsel bugs (p. 127).

Monitoring

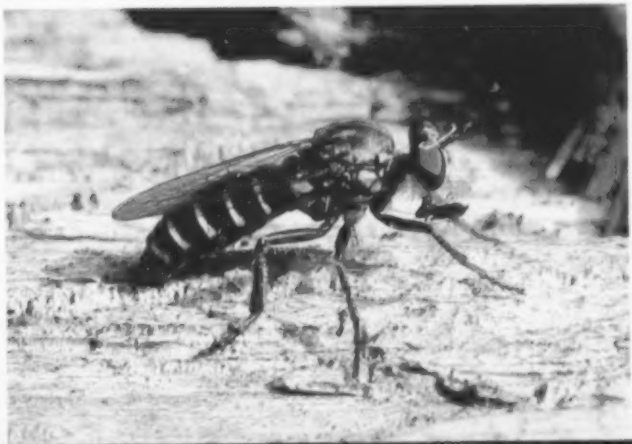
ADULTS: Use sweep net to sweep shrubs and tree limbs in clearings in or near wooded areas.

LARVAE: Examine soil, leaf litter, and decaying wood.

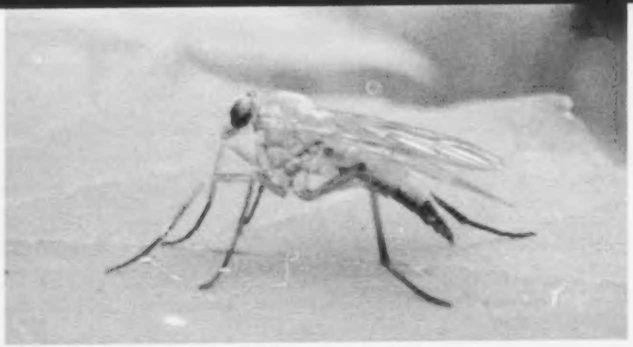
CONSERVATION

Avoid applying pesticides toxic to adults and larvae when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

COMMENTS: Adults use their piercing mouthparts to pierce the soft-body tissue of prey and inject toxic saliva that paralyzes and digests body contents which are sucked up. Perches on ground vegetation in open areas or on stones, rocks, and branch terminals to ambush passing insects.

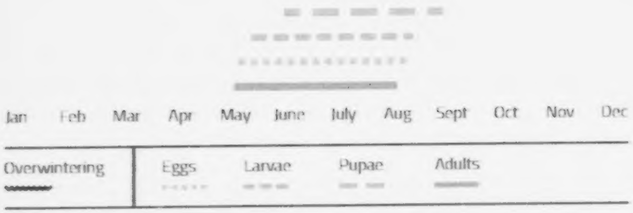


Robber fly – adult (*Cyrtopogon lutatius*)
Pascal Hedell, Flickr



Snipe fly – adult
Ryan Hodnett, Wikimedia Commons

Flies, snipe



Hosts/Prey

ADULTS Small insects, and/or nectar and honeydew.

LARVAE Small soil-inhabiting soft-bodied insects.

Identification

ADULTS 8–15 mm long, brown or gray body, sometimes with white, yellow, or green spots or bands and short, tapered abdomen; large, round head, long legs; transparent wings may be spotted, or smoky with dark veins.

MATURE LARVAE Up to 16 mm long, pale yellow to cream, with 4 terminal lobes. Larvae of some terrestrial species form funnel traps in soil to capture prey.

Life Cycle

Very little is known about the life cycle of snipe flies.

Similar Species

None.

Monitoring

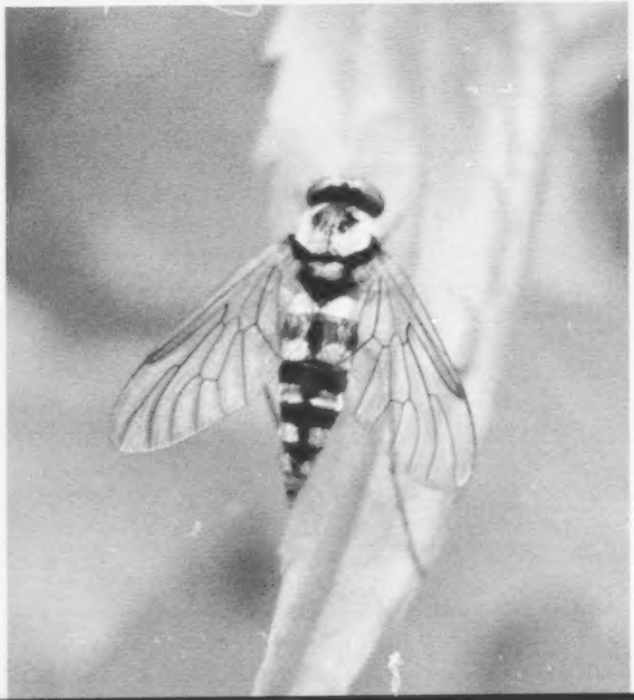
Scout for adults using sweep net or plant beating onto trays.

Conservation

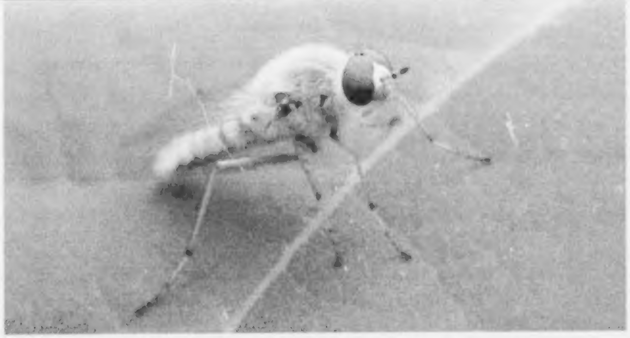
Avoid applying pesticides toxic to adults when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

Comments

Depending on species, larvae develop in aquatic sites or in decaying vegetation, rotting wood, or moist soil in shaded areas. Larvae of terrestrial species are known as wormlions.

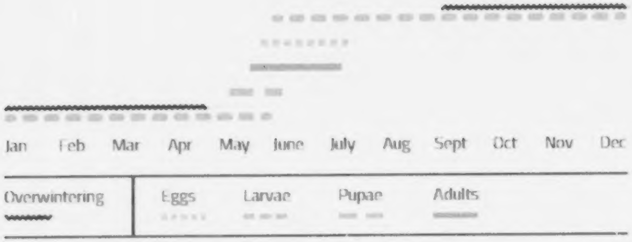


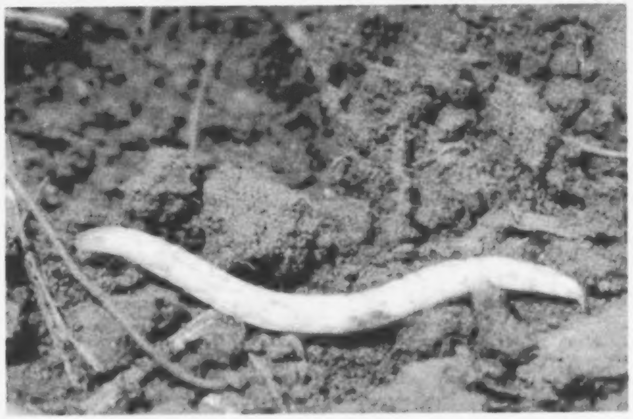
Ornate snipe fly – adult (*Chrysopilus ornatus*)
Darrin O'Brien (Stylurus), Flickr



Stiletto fly – adult
(*Spiriverpa senex*)
Paul Bedell, Flickr

Flies, stiletto





Stiletto fly – larva
Mike Dolinski, MikeDolinski@hotmail.com

Hosts/Prey

ADULTS: Nectar, honeydew, and pollen.

IMMATURES: Soil dwelling larvae and pupae of flies, beetles, and moths; and eggs of grasshoppers.

Identification

ADULTS: 4-14 mm long body depending on species; large dark eyes; abdomen is usually grayish, slender, hairy, and pointed.

MATURE LARVAE: 6-18 mm long, legless; cylindrical, smooth, white or pinkish, very long and thin body with tapered ends; head capsule is dark and narrower than the body. Will thrash around when disturbed.

Life Cycle

Overwinter as mature larvae that pupate in the spring. Eggs are laid in the soil. One generation per year.

Similar Species

Adults resemble robber flies (p. 119).

Monitoring

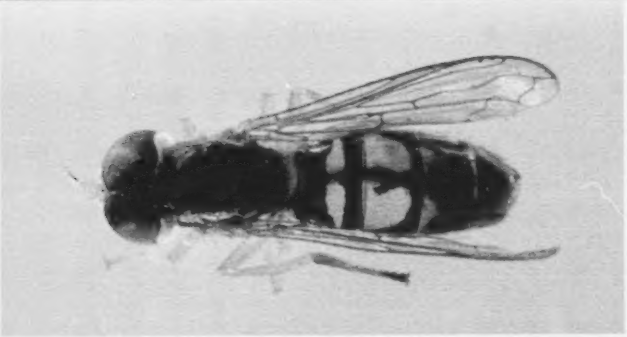
Adults are uncommon; prefer open areas near sand dunes and sandy soils.

Conservation

None.

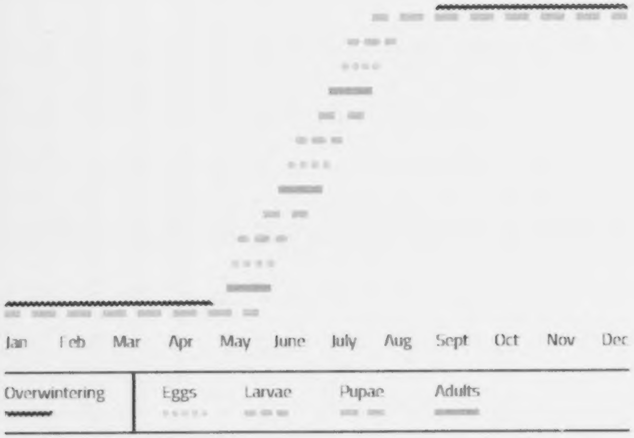
Comments

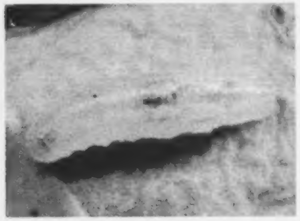
Very little known about the life cycle and behaviour of this group of flies.



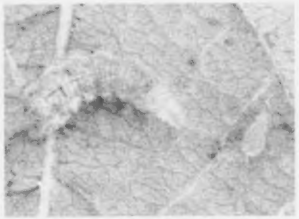
Syrphid fly – adult
(*Toxomerus marginatus*)
Tyler Wist, AAFC

Flies, syrphid
(hoverflies)





Syrphid fly – larva
Alberta Agriculture and Rural Development



Syrphid fly – larva
John Gavloski, Manitoba Agriculture, Food and Rural Development

Hosts/Prey

ADULTS: Nectar, pollen, and aphid honeydew.

LARVAE: Aphids (pp. 59-70).

Identification

ADULTS: 8-15 mm long, brightly-coloured with yellow, brown and black or entirely black or brown. Smooth hairless bodies, and one pair of transparent wings.

MATURE LARVAE: 10-15 mm long, somewhat flattened legless maggots; yellowish, green to pale brown with pale stripes; body narrows towards the head. Prominent brown spiracles (breathing tubes) on the posterior end.

Life Cycle

Overwinter as pupae on plants, under debris and in the soil. Females lay visible white, elongate, finely textured eggs singly in aphid colonies. Two to four overlapping generations per year depending on weather.

Similar Species

Confused with yellowjacket wasps because of hovering behaviour and similar color pattern of common species. Yellowjackets have 2 pairs of transparent wings compared to only 1 pair for syrphid flies.

Monitoring

Visual inspection of plants or use sweep net to detect adults and larvae.

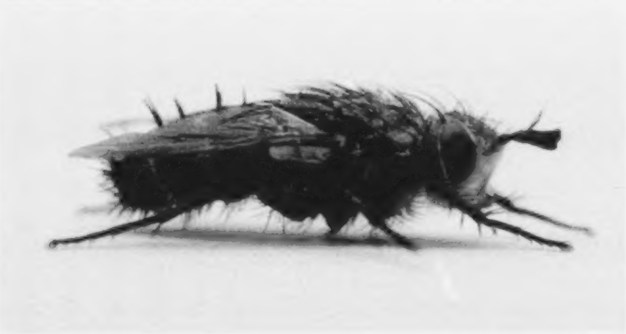
Conservation

Avoid applying pesticides toxic to adults and larvae when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Syrphid flies will later spread into nearby crops as prey populations develop.

Comments

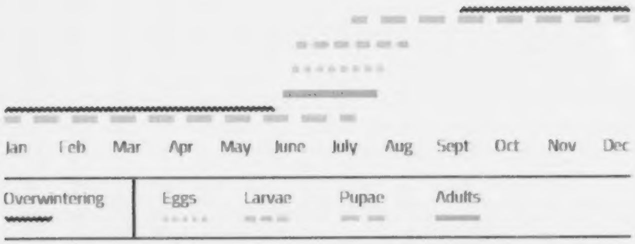
Larvae raise and swing their "head" side-to-side in search of aphids. As many as 400 aphids may be consumed by one larva during its development period. Adults are important pollinators. Population development stops as aphid populations disappear due to predation from the many predators and parasitoids, and as aphid colonies mature and produce winged sexual forms.

Syrphid fly – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development



Tachnid fly – adult
Alberta Agriculture and Rural Development

Tachinids



Tachnid fly – adult (*Bombyliopsis abrupta*)
David A Hoffmann, Flickr

Tachnid fly – adult (*Bombyliopsis abrupta*)
David A Hoffmann, Flickr

Hosts/Prey

ADULTS: Nectar of flowers, honeydew from aphids, scales, and mealybugs.

IMMATURES: Internal parasitoids of moth and butterfly, sawfly and beetle larvae, and of adult moths, beetles, grasshoppers, wasps and other flies, and all plant bug life stages.

Athrycia cinerea (Coq.) is a parasitoid of bertha armyworm (p. 74), armyworm (p. 73), fall armyworm (p. 76) and wheat head armyworm (p. 77).

Myiopharus macellus (Reinhard) is an important natural enemy of the sunflower beetle (p. 20).

Identification

ADULTS: 5-15 mm long, bristly body, pale or dark brown, red or metallic green with variously coloured patterns on abdomen which has many bristles, especially towards the end; one pair of transparent wings with distinct venation and may have yellowish or pale brown markings. Adult *Athrycia cinerea* are 7-9 mm long.

MATURE LARVAE: 6-16 mm long, whitish maggot-like body with well developed mandibles used to consume internal tissues and fat bodies.

Life Cycle

Depending on species, females lay one to several white eggs on a host. Larvae burrow into host body to develop, and then leave the body to pupate in a puparium in the soil or under ground cover. *Athrycia cinerea* overwinters as pupae in the soil. There is one generation per year as follows:

Similar Species

Some species resemble a bristly house fly (*Musca domestica* Linnaeus), flesh fly (Sarcophagidae), horse fly (Tabanidae), wasp, or bee. In bertha armyworm larvae, larvae of the ichneumonid parasite *Banchus flavescens* Cresson (p. 135) may also be present and will kill *Athrycia* larvae.

Monitoring

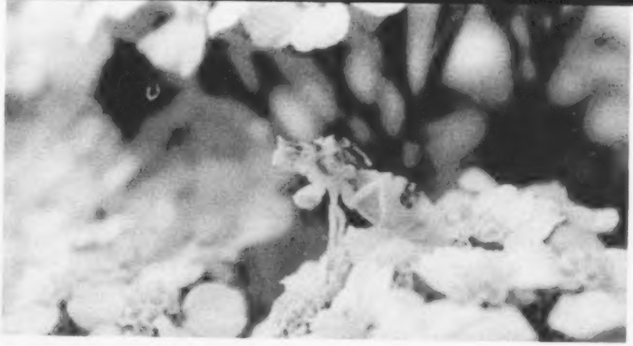
Examine caterpillars and other hosts for a small white elongate egg attached to the body. If a caterpillar appears sluggish or lethargic when handled, open it up and look for a parasite larva.

Conservation

Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and pollen. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides. Spring or fall cultivation could injure or kill pupae.

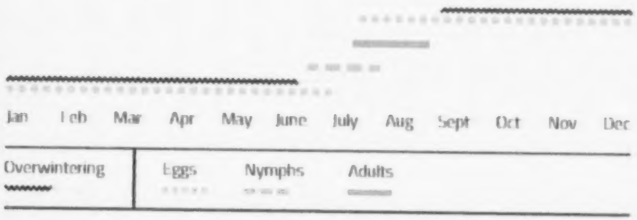
Comments

Athrycia cinerea Coq. larvae do not prevent host larvae from causing crop loss. However populations can build up and help end host outbreaks after 3–4 years.



Ambush bug – adult
(*Phymata* sp.)
Tyler Wist, AAFC

Bugs, ambush



Hosts/Prey

Feed on bumblebees, honey bees, wasps, butterflies, and flies.

Identification

ADULTS: 5–12 mm stout-bodied bugs, most with raptorial (grasping) front legs, a wide rear-end, and cryptic coloration.

MATURE NYMPHS: Resemble adult shape but smaller, no wings, are less spiny, and have no dark colouration.

Life Cycle

Overwinter as eggs on leaves. Females lay eggs within a foamy mass on undersides of leaves.

Similar Species

Assassin bugs (p. 125) have long, narrow heads compared to ambush bugs and their forelegs are not as thickened as ambush bugs.

Monitoring

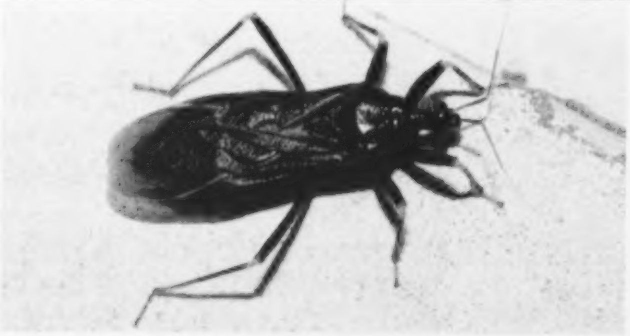
Visual inspection of flowers or use a sweep net to detect adults and nymphs. Egg masses are hard to find.

Conservation

Avoid applying pesticides toxic to adults and nymphs when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

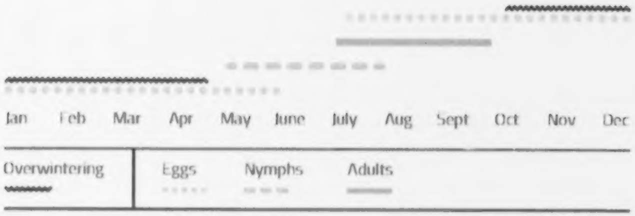
Comments

Their name refers to the way they lie in wait for their prey, usually camouflaged in the flower. They grasp their prey and pierce the body, injecting enzymes that digest contents which are sucked up.



Assassin bug – adult
(*Reduvius personatus*)
Keith Roragen, Flickr

Bugs, assassin



Assassin bug – adult
(*Reduvius personatus*)
Ferran Turmo Gort, Flickr

Hosts/Prey

Generalist predators, feeding on immature and adults stages of many harmful and beneficial insects.

Identification

ADULTS: 13-25 mm long with long narrow legs, a cone-shaped, elongated head with a distinct "neck" behind the often reddish eyes, and a prominent wide beak curving under the body; abdomen somewhat wider in the middle; colouration varies with hues of brown, black, red, or orange. The forelegs are bristly and may be somewhat raptorial (grasping) to capture and hold prey.

MATURE NYMPHS: Resemble adults but less colourful and have no wings.

Life Cycle

Overwinter as brown, cylindrical eggs in small tight clusters on leaves or in cracks, under rocks or in other sheltered spots. One generation per year.

Similar Species

Ambush bugs (p. 124) which are smaller and have distinctive raptorial (grasping) forelegs.

Monitoring

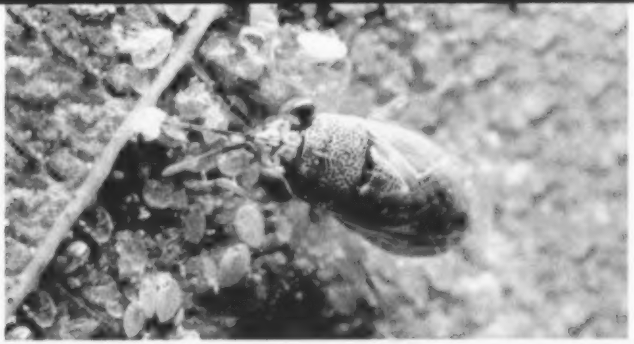
Visual inspection of plants or use a sweep net to detect adults and nymphs. Handle with care as they can cause a painful bite when captured

Conservation

Avoid applying pesticides toxic to adults and nymphs when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

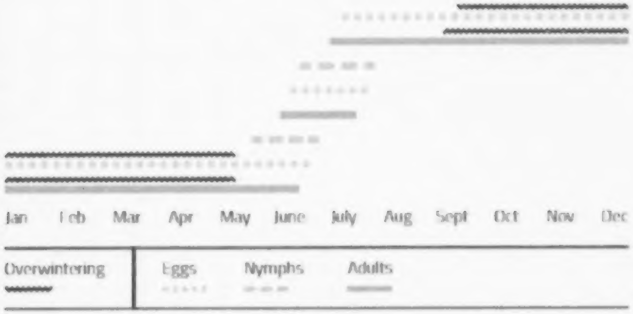
Comments

Assassin bugs are very aggressive predators. They lie in wait for insects and then stab the prey with their piercing and sucking beak. They inject toxic saliva that paralyzes the prey and dissolves tissues which are then sucked up.



Big-eyed bug – adult
Jack Dykinga, USDA-ARS

Bugs, big-eyed



Hosts/Prey

General predators that feed on all stages of soft-bodied insects and on mites; attracted to colony-forming prey; will feed on nectar and honeydew when prey is scarce.

Identification

ADULTS 3–5 mm long, oblong-oval, black, gray or tan coloured body; head broader than long; prominent eyes curve backward and overlap the front of the thorax; tips of antennae slightly swollen.

MATURE NYMPHS Resemble adults but smaller and no wings.

Life Cycle

Overwinter as adults or eggs, depending on species under soil debris and other protected sites. Eggs are laid singly or in clusters on leaves near prey colonies. Usually two overlapping generations per year.

Similar Species

Chinch bugs (p. 48).

Monitoring

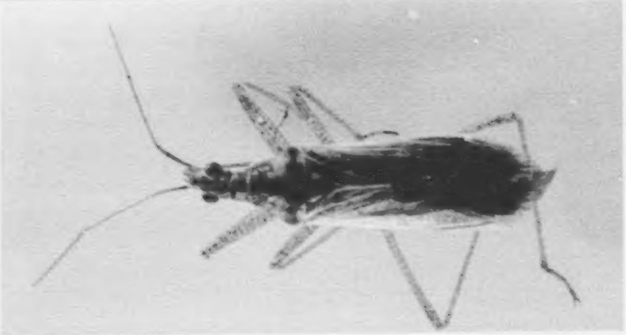
Use sweep nets to collect mobile stages.

Conservation

Avoid applying pesticides toxic to adults and nymphs when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

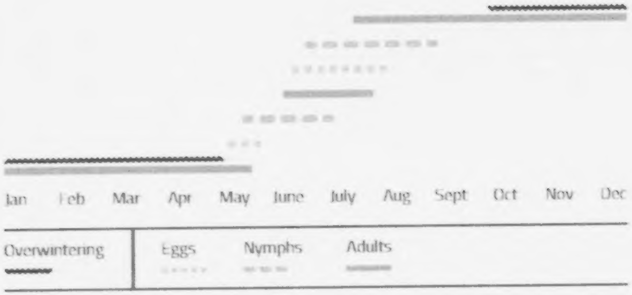
Comments

Occur in many habitats, including fields, gardens, and turf grass. Research has found that nymphs can eat as many as 1600 spider mites before reaching adulthood, while adults are reported to consume up to 80 mites/day.



Damsel bug – adult
(*Nabis alternatus*)
Tyler Wist, AAFC

Bugs, damsel



Damsel bug – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development

Hosts/Prey

Aphids (pp. 59-70), caterpillars, insect eggs,

, lygus bugs (p. 51), and leafhoppers (pp. 45-47); they also feed on other predaceous bugs.

Identification

ADULTS: 7–12 mm long, tan or gray slender body that tapers towards the head; long legs, with forelegs somewhat thickened and spiny for grasping prey. Well developed wings.

MATURE NYMPHS: Resemble adults but smaller, paler colour, and no wings.

Life Cycle

Overwinter as adults under groundcover and winter crops such as winter grain and alfalfa. Females insert eggs in plant tissue. Two or more generations per year.

Similar Species

Assassin bugs (p. 125).

Monitoring

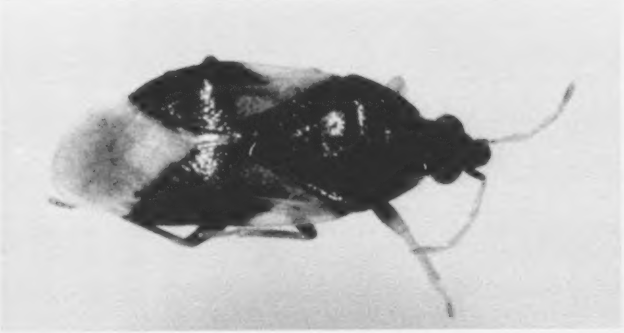
Visual inspection of plants or use sweep net to detect adults and nymphs. Will "bite" if handled.

Conservation

Avoid applying pesticides toxic to adults and nymphs when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

Comments

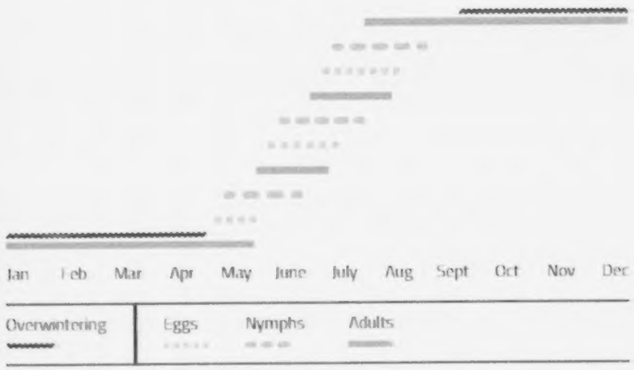
Both adults and nymphs are fast, aggressive predators. They grasp their prey and pierce the body, injecting toxic saliva that paralyzes prey and digests body contents they then suck up.



Minute pirate bug – adult
(*Orius tristicolor*)
Tyler Wist, AAFC

Bugs, minute pirate

Anthocoris spp./*Orius* spp.



Minute pirate bug – adult
John Gavloski, Manitoba Agriculture, Food and Rural Development

Hosts/Prey

Adults and nymphs feed on all stages of aphids (pp. 59-70), mites (pp. 14-16), scales, thrips (p. 107), moths, and other small insects. Will feed on nectar and pollen when prey is scarce.

Identification

ADULTS: 2-5 mm long, oval, shiny somewhat flattened body with a black and white X-patterned back; pointed head and piercing-sucking mouthparts.

MATURE NYMPHS: 2-4 mm shiny, wingless, yellowish-pink to reddish brown with darker abdomen.

Life Cycle

Adults overwinter in bark crevices, under plant debris and other protected sites outside fields. Females lay eggs in plant tissue. Up to three or four generations per year depending on location.

Similar Species

Chinch bugs (p. 48), young lygus bug nymphs (p. 51).

Monitoring

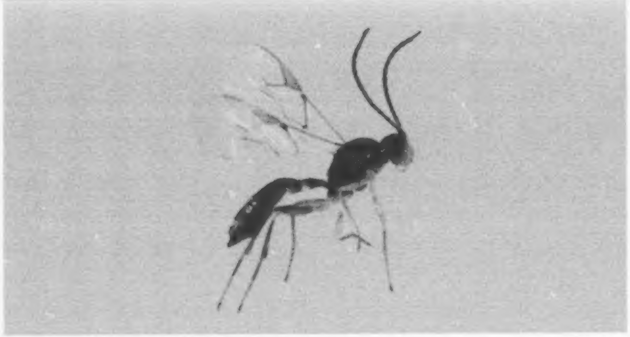
Use sweep net to sample for adults and nymphs in crops; use a beating tray to sample shrubs and trees.

Conservation

Avoid applying pesticides toxic to adults and nymphs when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Adults will later spread into nearby crops as prey populations develop.

Comments

Will inflict a painful "bite" when handled. Some species of *Orius* are produced commercially for augmentative release.



Aphidiinae – adult (*Aphidius avenaphis*)
Tyler Wist, AAFC

Aphidiinae

Aphidius spp.

Hosts/Prey

Over 40 species of aphids.

Aphidius avenaphis (Fitch): English grain aphid (p. 60).

A. colemani Viereck: green peach aphid (p. 61), oat-birdcherry aphid (p. 62).

A. matricariae Haliday: bean aphid, potato aphid (p. 64), pea aphid (p. 63), green peach aphid (p. 61), Russian wheat aphid (p. 65).

A. ervi Haliday: potato aphid (p. 64), pea aphid (p. 63), green peach aphid (p. 61), Sitobion spp. (p. 60), Schizaphis sp. (p. 70), *Rhodobium* spp.

A. smithi Sharma et Subba Rao: aphids (pp. 59-70).

Identification

ADULTS: 2–3 mm long, usually black colour, with pointed abdomen, long antennae, and two pair of transparent wings with reduced venation.

MATURE LARVAE: 2–3 mm long, whitish, maggot-like, and legless.

Life Cycle

Females lay their 100-350 eggs singly in young aphids using their short ovipositors. Egg to adult development occurs within the host, and takes about 2-4 weeks, depending on species and temperatures. New adults chew a hole in a mummified aphid to exit and immediately begin to search for aphid hosts. They overwinter as larvae or pupae in aphid mummies. There are three or more generations per year depending on species, food supply and temperatures.

Similar Species

Adult *Aphidius* resemble the adult midge parasitoid, *Aphidoletes aphidimyza*, except the latter has only one pair of transparent wings and its free-living 2 mm long, maggot-like orange larvae attack aphids much like syrphid fly larvae. *Aphidius* females can be confused with female Braconids except the latter have a noticeable ovipositor.

Monitoring

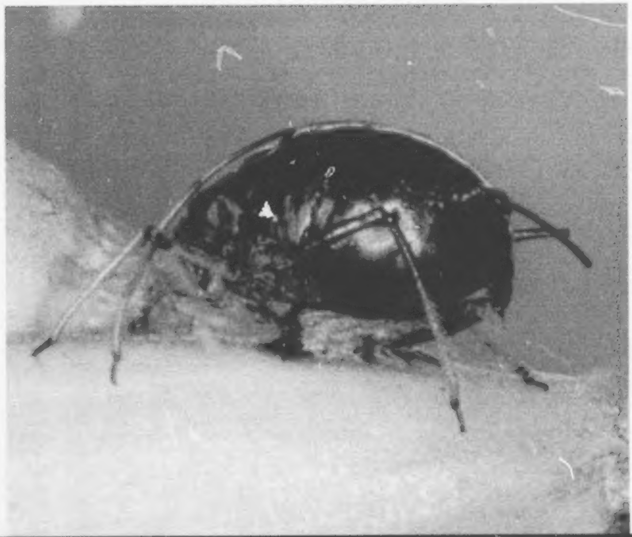
Examine aphid colonies for presence of tan-coloured mummified aphids, some with round holes (see Comments below).

Conservation

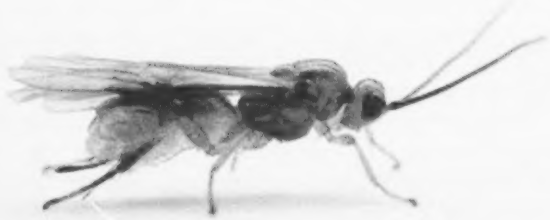
Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and honeydew as well as attack any prey present. Adults locate aphid colonies from a long distance by "alarm signals" produced by aphid-infested plants. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

Comments

Adults feed on honeydew and flower nectar. A parasitized aphid swells up when the larva pupates inside its body, turns tan colour, and the body becomes "mummified" with parchment-like integument. A small round hole in aphid mummies is indicative of parasitism by *Aphidius* spp.



Aphidiinae – parasitized English grain aphid
Tyler Wist, AAFC



Braconid wasp – adult
Alberta Agriculture and Rural Development

Braconidae

Hosts/Prey

Aphids, and eggs or larvae of Lepidoptera, Coleoptera, Diptera, Hymenoptera, and Heteroptera.

Bracon cephi (Gahan), B. lissogaster Muesebeck: wheat stem sawfly (p. 72)

Chelonus phaloniae Mason: banded sunflower moth (p. 97)

Cotesia glomerata (Linnaeus): imported cabbageworm (p. 82), *Pieris* spp.

Cotesia marginiventris (Cresson): cabbage looper (p. 96), black cutworm (p. 87), corn earworm (p. 95), variegated cutworm (p. 94), armyworm (p. 73), and fall armyworm (p. 76)

Cotesia plutellae (Kurdjumov): diamondback moth (p. 98)

Dacnusa dryas (Nixon): alfalfa blotch leafminer (p. 36)

Macrocentrus cingulum Brischke: European corn borer (p. 79)

Microctonus melanopus (Ruthe): cabbage seedpod weevil adults (p. 25)

Microplitis mediator (Haliday): bertha armyworm (p. 74)

Microplitis plutellae (Haliday): diamondback moth (p. 98)

Peristinus pallipe (Curtis), *P. digoneutis* Loan: lygus bugs (p. 51)

Identification

ADULTS: 2-15 mm long, usually black-brown in colour (sometimes with reddish markings), with narrow waist connected to the abdomen which is same length as head and thorax combined; long antennae, and two pair of transparent wings with reduced venation; females have a noticeable ovipositor.

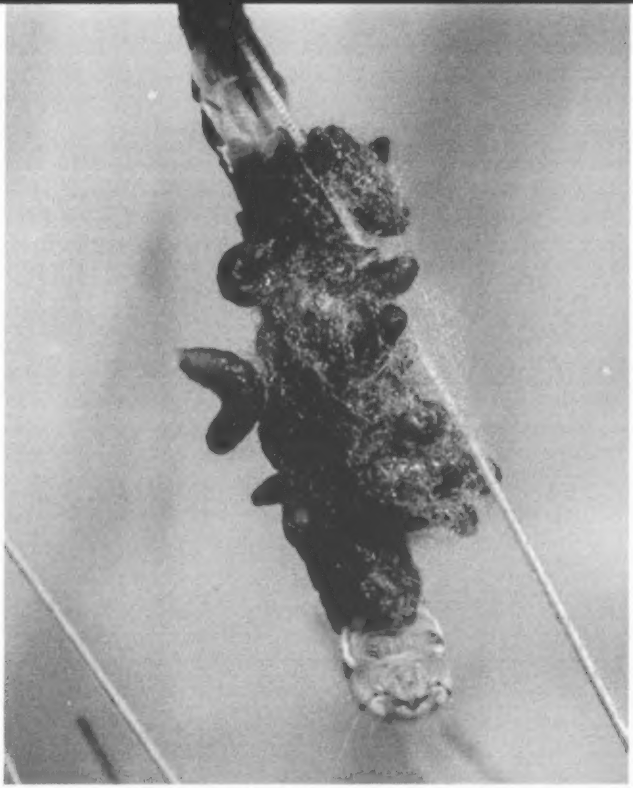
MATURE LARVAE: 2-16 mm long, whitish, maggot-like, and legless with visible mandible.

Life Cycle

Females use their long ovipositor to lay their eggs singly in or on hosts. Larvae develop inside or outside the host body, but pupate on or beside the body in white silken cocoons. Egg to adult development takes about 10-28 days, depending on species and temperatures. New adults chew a hole in mummified aphid to exit and immediately begin to search for aphid hosts. Overwinters as larvae or pupae in hosts. There are three or more generations per year depending on species, food supply, and temperatures.

Braconid wasp – adult
(*Perstenus digoneutis*)
parasitizing tarnished plant bug
Scott Bauer, USDA Agricultural
Research Service, Bugwood.org

Braconid wasp – adult
(*Cotesia marginiventris*)
parasitizing beet armyworm
Debbie Waters, University of Georgia,
Bugwood.org



Braconid wasp – cocoon
Alberta Agriculture and Rural Development

Similar Species

Resemble small ichneumons (p. 135) and adult *Aphidius* spp. (p. 129) except latter lack the narrow waist and noticeable ovipositor. Parasitized aphids also become mummified similar to *Aphidius* spp.

Monitoring

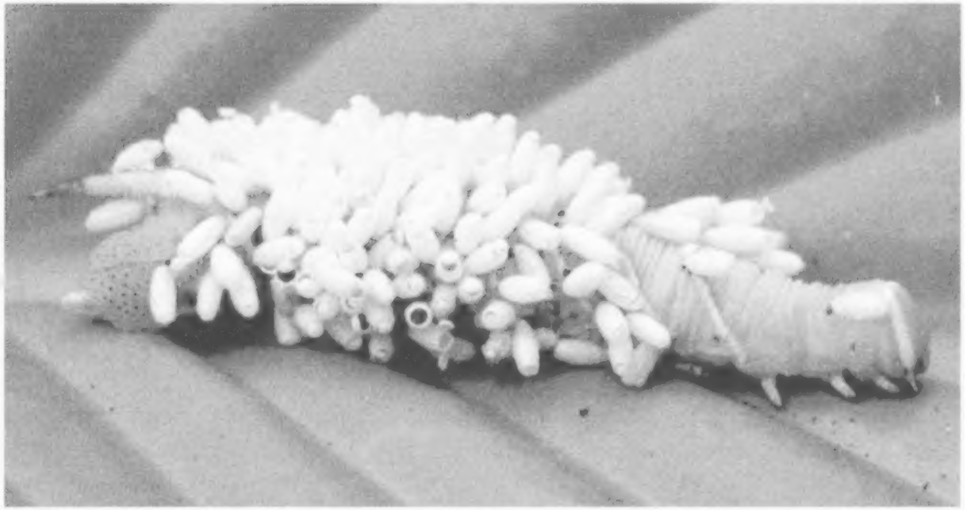
Use a sweep net to detect adults from plants with small flowers. Examine overwintering Lepidoptera larva for parasitoid larvae, often visible through the skin of the host.

Conservation

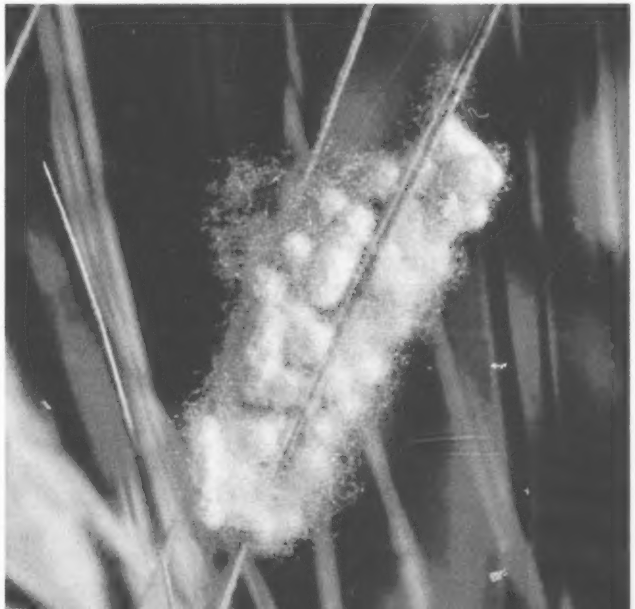
Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and honeydew as well as attack any prey present. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

Comments

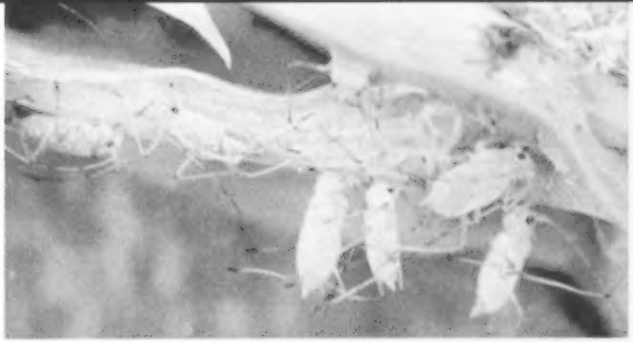
A very large group of parasitoids, the larvae of which either feed inside the host (endoparasitoid) or attached to the outside of the host (ectoparasitoid). In some species a single egg will divide many times to produce several larvae (polyembryonic). Several hundred larvae can develop in a single cutworm larva.



Braconid wasp – parasitized caterpillar
David Cappaert, Michigan State University, Bugwood.org



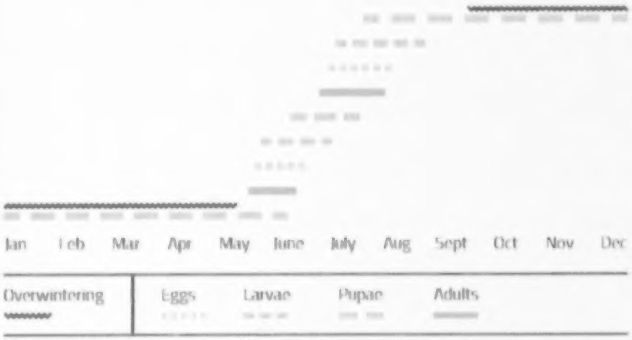
Braconid wasp – cocoon
Alberta Agriculture and Rural Development



Aphid midge – larva (*Aphidoletes* sp.)
Whitney Cranshaw, Colorado State University,
Bugwood.org

Cecidomyiidae, aphid midges

Aphidoletes spp.



Hosts/Prey

ADULTS: Nectar, plant sap, and honeydew.

LARVAE: Up to 60 species of aphids are primary food but also attack mites, scales, and their eggs.

Identification

ADULTS: 2–3 mm long, delicate dark brown to black flies with long slender legs and beaded antennae (often curled back over the body), one pair of transparent wings.

MATURE LARVAE: 3 mm long, pale to bright orange maggots (paler when young); two projecting anal spiracles (small tubes) relatively close together at their rear ends. Indistinct head with small strong jaws to grasp prey.

Life Cycle

Overwinters as pupae in the soil. Females lay up to 250 eggs over their short 10-day life span in aphid colonies. Larvae drop to the soil to pupate. Life cycle takes between 4 and 7 weeks. Up to 3 generations per year under favourable conditions.

Similar Species

Other species of midges attack crops (e.g. Hessian fly (p. 35), sunflower (p. 41), swede (p. 42), and wheat midges (p. 43)) or feed on plant detritus and fungi. Similar looking non-pest flies may be present in and around flowering crops and adjacent vegetation feeding on nectar, plant sap, and honeydew.

Monitoring

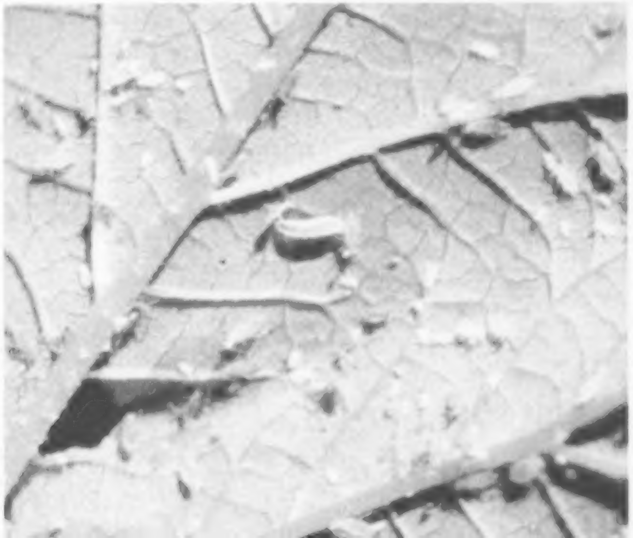
Visual inspection of aphid colonies should reveal if the orange larvae are present; use sweep net to detect adults on plants.

Conservation

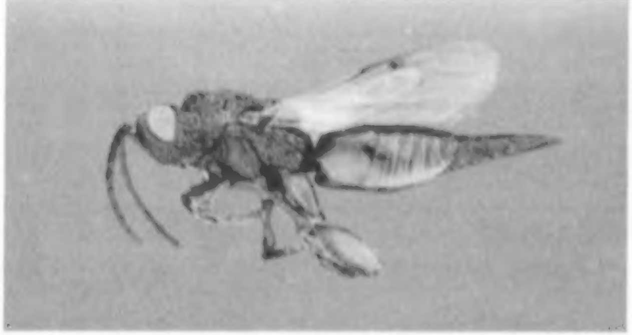
Preserve unsprayed flowering vegetation near fields where adults can feed on nectar, plant sap, and honeydew as well as lay eggs. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

Comments

Larva injects toxic saliva into the aphid to paralyze it, and then sucks up body fluids through a hole cut in the aphid's body. Not all paralyzed aphids are eaten. One larva can kill up to 65 aphids a day. Commercially produced for inundative releases.



Aphid midge – larva (*Aphidoletes* sp.) in pea aphid colony
Whitney Cranshaw, Colorado State University,
Bugwood.org



Chalcid wasp – adult (*Phasgonophora sulcata*)
Michael Gates, Encyclopedia of Life, EOL.org

Chalcididae

Hosts/Prey

ADULTS Nectar from flowers, aphid honeydew, and host blood (when laying eggs).

LARVAE Internal parasitoids of larvae and/or eggs of 12 insect orders (including other parasitoids and predators) and spiders.

Identification

ADULTS Common species are very small (< 6 mm long) black, blue-black, or green, may be metallic with bright yellow legs or body parts. Short elbowed antennae, wings may be smoky with very simple venation, and are held flat at rest (some are wingless); well-developed chewing mouthparts. The female ovipositor (if present) extends from the lower front of the abdomen. Hind legs are more robust than the front pairs.

MATURE LARVAE < 6 mm long; white, grub-like with simple head; chewing mouthparts.

Life Cycle

Most chalcid wasps overwinter as adult females or as mature larvae in the host organism. Females lay 1–25 eggs (total around 200) into eggs, larvae, or pupae. Larvae develop and pupate in the host (host eggs gradually turn black). New adults chew their way out of the dead host to start a new generation. At least 3–4 generations per year.

Similar Species

Larger species can be confused with other adult parasitoids which generally have more wing venation and their hind legs are less robust.

Monitoring

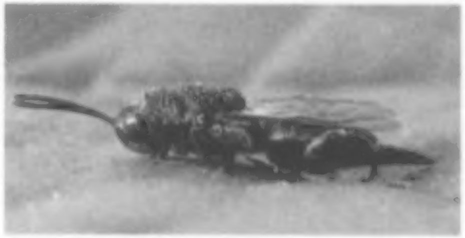
Sweep plants with small flowers for adults.

Conservation

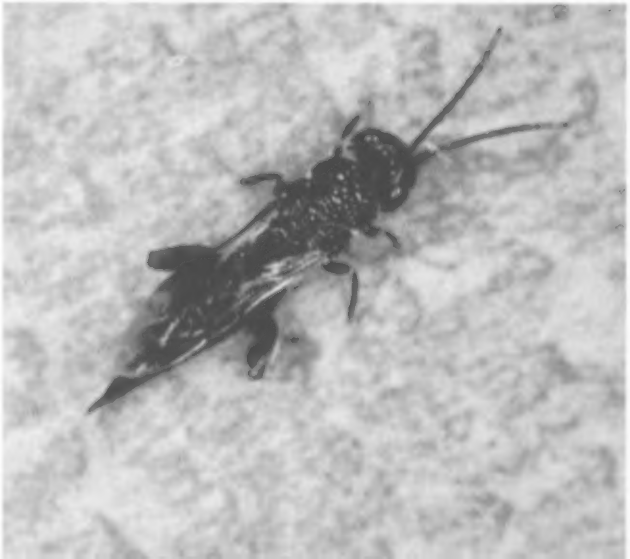
Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and honeydew as well as attack any prey present. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

Comments

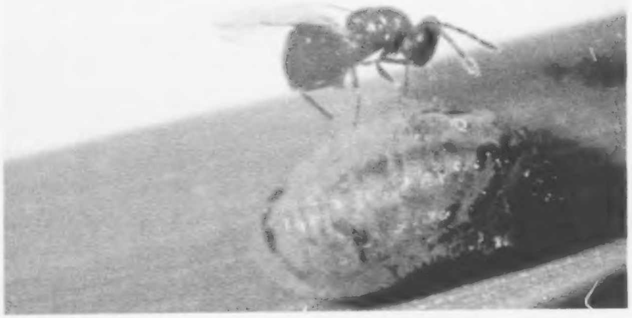
Chalcids belong to a very large group of important biological control agents capable of keeping pest populations in check if not disrupted by toxic insecticides. Adults will jump or feign death when disturbed.



Chalcid wasp – adult (*Phasgonophora sulcata*)
David Cappaert, Michigan State University, Bugwood.org



Chalcid wasp – adult (Phasgonophora sulcata)
Whitney Cranshaw, Colorado State University, Bugwood.org



Tetrastichus julis – adult parasitizing a cereal leaf beetle larva
Swaroop Kher, University of Alberta/AAFC

Eulophidae

e.g. *Tetrastichus julis* (Walker)

Hosts

ADULTS: Feed on nectar and aphid honeydew.

LARVAE: Internal parasitoid of the larvae of the cereal leaf beetle (CLB) (p. 18).

Identification

ADULTS: Up to 4 mm long, shiny black or blue-black body with pointed abdomen; 2 pair of transparent wings with very reduced venation; elbowed antennae.

MATURE LARVAE: 2-3 mm long, yellow, maggot-like.

Life Cycle

Overwinters as mature larvae in infested CLB larval cocoons in the soil. Adults emerge in spring and each female lays 4-6 eggs in CLB larvae in late May to late June. Second brood of adults emerge in July and lay eggs in late maturing CLB larvae. Second brood larvae overwinter.

Similar Species

Adults resemble those of other related parasitoids such as chalcids (p. 133), pteromalids (p. 137), and trichogrammids (p. 138).

Monitoring

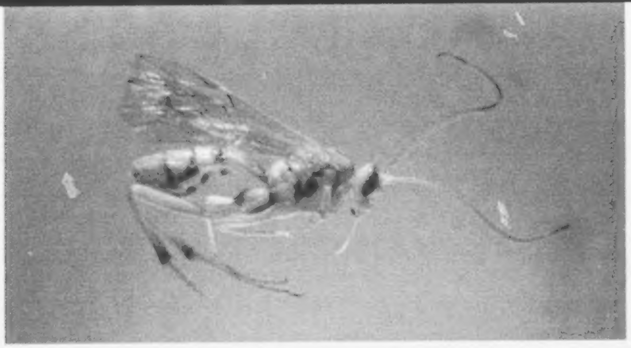
Use a sweep net to collect adults from plants with small flowers. Examine the contents of mature CLB larvae for the yellow larvae (visible to the unaided eye).

Conservation

Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and honeydew as well as attack any prey present on alternate hosts. Provide unsprayed corner or border of cereal leaf beetle-infested crops to allow establishment of *T. julis*. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

Comments

T. julis is an introduced parasitoid that can prevent development of economic populations of the cereal leaf beetle if allowed to become established. The small amount of crop injury sustained while allowing *T. julis* to become established is more than compensated for by not having to control cereal leaf beetle in the future. Another eulophid, *Pediobius eubius* (Walker) parasitizes the Hessian fly (p. 35).



Ichneumonid – adult (*Banchus flavescens*)
John Gavloski, Manitoba Agriculture, Food and Rural Development

Ichneumonidae

Hosts/Prey

ADULTS Nectar and aphid honeydew.

LARVAE Internal parasitoids of the eggs, larvae and/or pupae of Lepidoptera, Coleoptera, Diptera, Hymenoptera, and some spiders.

Bathyplectes curculionis (Thomson), *B. anurus* (Thomson): alfalfa weevil (p. 24)

Banchus flavescens Cresson: bertha armyworm (p. 74)

Diadegma insulare (Cresson): diamondback moth (p. 98)

Diadromus subtilicornis (Gravenhorst): diamondback moth (p. 98)

Glypta prognatha Dasche: banded sunflower moth (p. 97)

Identification

ADULTS 5–36 mm long; brown, red, or black body with variable markings; narrow waist, abdomen longer than thorax and head combined; ovipositor longer than body; long antennae. Males and females have different colours.

MATURE LARVAE 5–35 mm long, whitish, legless tapered body.

Life Cycle

Depending on species, overwinter as larvae, pupae, or adults inside hosts. Females use their long ovipositor to inject eggs into hosts. The number of generations per year varies according to species.

Similar Species

Adult ichneumons resemble adult braconids (p. 130) except they are larger and the ovipositor is relatively longer compared to body length.

Monitoring

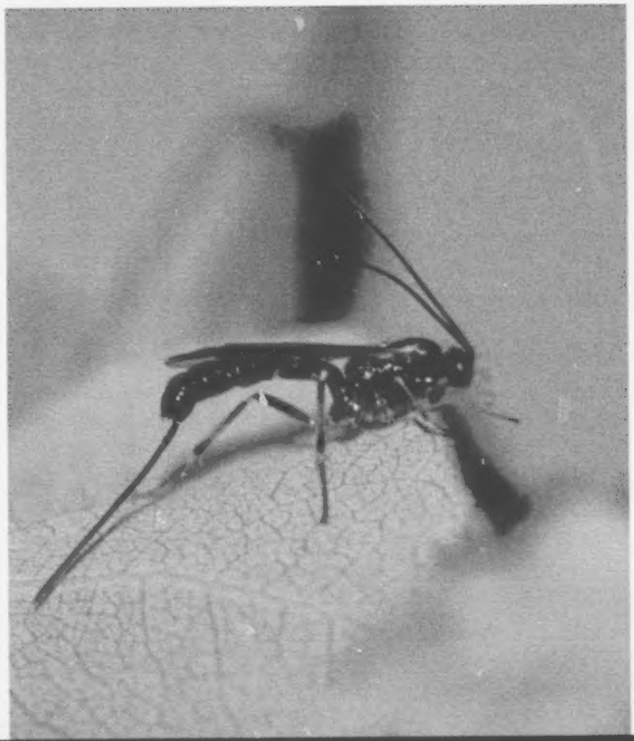
Adults can be collected using sweep nets or light traps.

Conservation

Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and pollen as well as attack any prey present. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

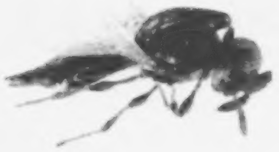
Comments

Cocoons of *Bathyplectes curculionis* and *B. anurus* are both about 3.5 mm long, oval, dark brown to black, and with a pale band around the circumference. The band of *B. anurus* is narrow, yellowish, smooth-edged, and slightly raised; for *B. curculionis*, the band is broader, white, has less defined margins, and is more flattened.



Ichneumonid – adult (sp.)
Edward H. Holsten, USDA Forest Service, Bugwood.org

Platygasteridae



Platygasterid – adult (*Inostemma* sp.)
Tyler Wist, AAFC

Hosts/Prey

ADULTS Nectar and plant juices.

LARVAE Most are internal parasites of plant-feeding midges (Diptera: Cecidomyiidae).

Euxestonotus error (Fitch): wheat midge (p. 43)

Platygaster hiemalis Forbes: Hessian fly (p. 35)

Platygaster tuberosula (Kieffer): wheat midge (p. 43)

Identification

ADULTS Minute, shiny black with reduced wing venation and antenna attached very low on the face.

MATURE LARVAE Less than 1.5 mm long; white body; worm-like with no vestigial legs.

Life Cycle

Adult *P. hiemalis* are active in the fall laying eggs in Hessian fly eggs and newly hatched larvae in which it overwinters. *E. error* has a similar life cycle to *Macroglenes penetrans* (p. 137).

Similar Species

Adults resemble adult chalcids (p. 133).

Monitoring

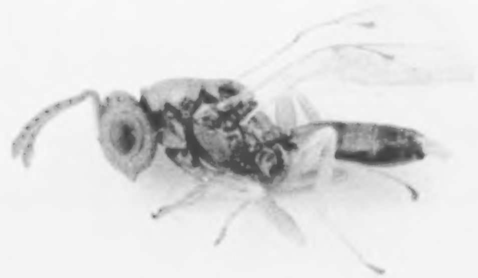
None.

Conservation

Preserve unsprayed flowering vegetation near fields where adults can feed on nectar and pollen as well as attack any prey present. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

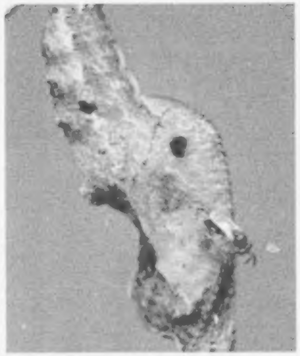
Comments

Wheat midge larvae parasitized by *E. error* are still capable of damage to the crop during the current season. *P. hiemalis* can parasitize up to 50% of a Hessian fly population.

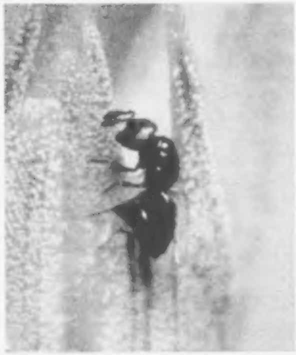


Pteromalid – adult (*Pteromalus puparum*)
Kooresh McCormack, Natural History Museum: Hymenoptera Section, EOL.org

Pteromalidae



Pteromalid – adult (*Pteromalus puparum*) exiting a parasitized cocoon
Sturgis McKeever, Georgia Southern University, Bugwood.org



Pteromalid – adult (*Macroglenes penetrans*)
AAFC

Pteromalid – adult (*Pteromalus puparum*) exiting a parasitized cocoon
Sturgis McKeever, Georgia Southern University, Bugwood.org

Hosts/Prey

ADULTS Nectar.

LARVAE Internal parasitoids of the immature stages of many hosts.

Macroglenes penetrans (Kirby): wheat midge (p. 43)

Pteromalus puparum Linnaeus: imported cabbageworm (p. 82)

Trichomalus lucidus (Walker): cabbage seedpod weevil larvae (p. 25) [Note: often misidentified as *T. perfectus* (Walker)]

Identification

ADULTS *M. penetrans* is 1-2 mm long; *P. puparum* is 3-4 mm long; both have shiny black bodys with elbowed antennae and 2 pairs of transparent wings with much reduced venation. Abdomen of *M. penetrans* appears somewhat triangular in profile.

MATURE LARVAE 1-4 mm legless, maggot-like, cream to yellow in colour.

Life Cycle

M. penetrans overwinter as larvae inside the wheat midge larvae. Larvae complete development in the spring, which kills the midge larvae, and then pupate. Emerging females lay eggs in wheat midge eggs. The parasite larvae continue to develop in the midge larvae through the season. *P. puparum* overwinter as mature larvae in host pupae. Females lay eggs in either pre-pupae or newly formed pupae, eventually killing the pupae.

Similar Species

Adults resemble chalcid adults (p. 133).

Monitoring

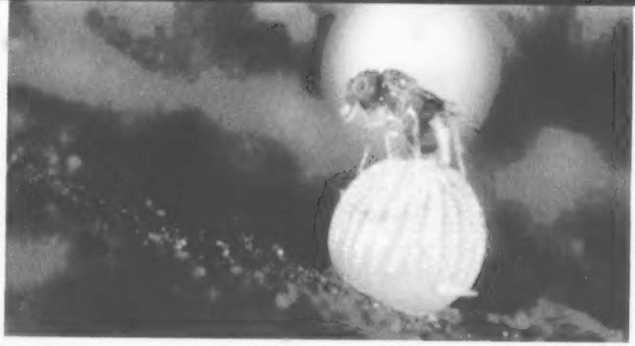
None.

Conservation

Avoid use of pesticides toxic to the adults and larvae.

Comments

Wheat midge larvae parasitized by *M. penetrans* are still capable of damage to the crop during the current season. Up to 40% of overwintering midge larvae can be killed by this parasitoid.



Trichogrammid – adult (*Trichogramma* sp.) parasitizing an egg
Jack Kelly Clark, University of California Statewide IPM Program

Trichogrammididae

Trichrogramma spp.

Hosts/Prey

ADULTS Nectar, honeydew, and plant sap.

LARVAE *Trichogramma* spp. are major egg parasites of Lepidoptera (over 200 spp.), but also attack eggs of some Hymenoptera, Neuroptera, Diptera, Coleoptera, and Heteroptera.

Trichogramma minutum Riley: armyworms (pp. 73-77), cutworms (pp. 86-94)

T. inyoense Riley: bertha armyworm (p. 74)

T. evanescens Westwood: imported cabbageworm (p. 82), corn earworm (p. 95), cabbage looper

T. praetiosum Riley: beet webworm (p. 102), diamondback moth (p. 98)

Identification

ADULTS Minute (0.2-1.5 mm long), usually yellow, stout bodies with reddish eyes.

MATURE LARVAE Minute (0.2-1.5 mm long), maggot-like, whitish in colour.

Life Cycle

Overwinter as pupae in host eggs in leaf litter in or near fields. Females insert one or more eggs into a host egg; larvae consume the egg contents as they develop to the adult stage which emerges through a hole cut in the egg shell. Several generations per season; generation time is 10-14 days depending on weather.

Similar Species

None.

Monitoring

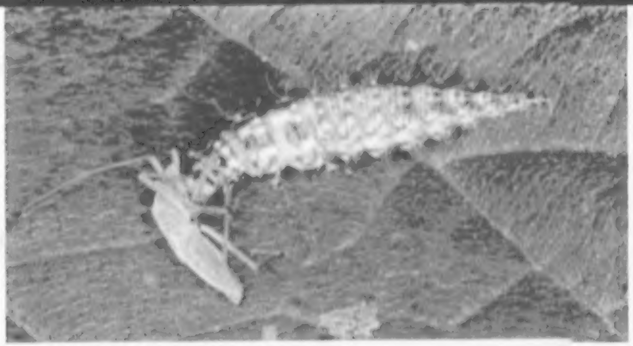
Parasitized eggs gradually turn black as the parasitoid larvae develop. Check host eggs for presence of small circular exit holes.

Conservation

Preserve unsprayed vegetation (e.g. wild carrots, dill, golden rod, leguminous plants, and flowering vegetables) near fields where adults can feed as well as attack any host eggs present. Such areas offer a refuge for populations which can spread into adjacent crops in the absence of harmful pesticides.

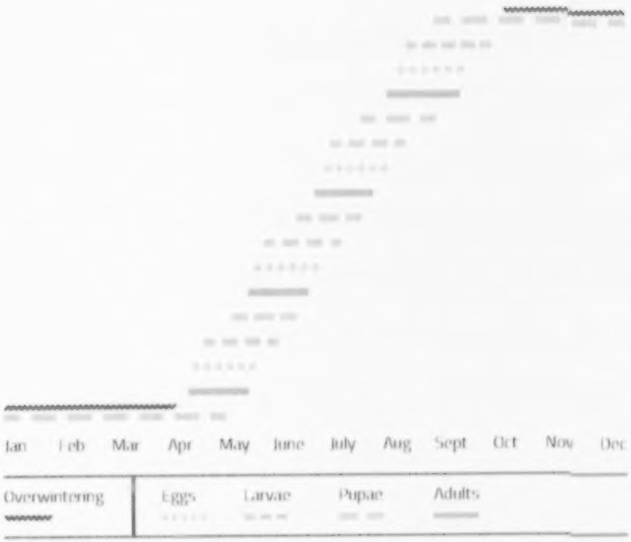
Comments

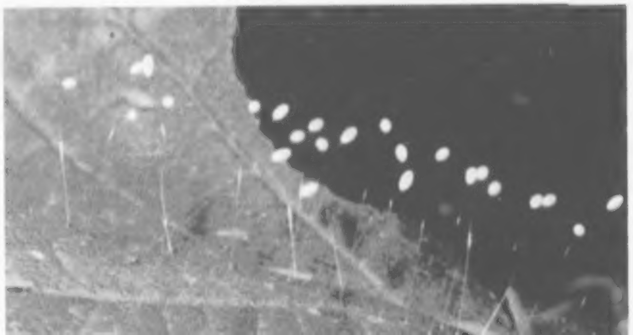
Several species are commercially available for purchase to release in crops. Any innundative releases must be made when target species adults are flying and laying eggs.



Green lacewing – larva eating leafhopper
Mike Dolinski, MikeDolinski@hotmail.com

Lacewing, green
Chrysopa spp.





Green lacewing – eggs
Mike Dolinski, MikeDolinski@hotmail.com

Hosts/Prey

ADULTS: Feed on same prey as larvae.

LARVAE: Aphids (pp. 59-70), spider mite motiles and eggs (pp. 14-16), small caterpillars, insect eggs, thrips (p. 107), leafhopper nymphs (pp. 45-47), and mealybugs (p. 71).

Identification

ADULTS: 14-20 mm long, pale yellow to green, narrow body with 2 pair of clear, delicate lace-like wings with green venation that fold roof-like over the body when at rest; small head with large, shiny golden to red eyes, sickle-shaped mouthparts, and long slender antennae.

MATURE LARVAE: Up to 15 mm long, alligator-shaped, body with clumps of short bristles; colour yellowish to mottled gray with red, brown, or black markings; prominent sickle-shaped mouthparts extend forward from head. Commonly call aphidlions.

Life Cycle

Most species overwinter as pupae in spherical white cocoons in sheltered sites in and around fields. Females lay oblong white eggs on hair-like stalks in rows on undersides of leaves. Egg stalks protect against cannibalistic siblings and predators. Three or four generations per year.

Similar Species

Adults of the less common brown lacewing (*Hemerobius* spp.) are smaller (10-12 mm long) and brown, beige, or dark green with lace-like wings covered with hairs. Larvae resemble green lacewing larvae but smaller, narrower body and shorter sickle-shaped mouthparts. It feeds on the same prey.

Scouting

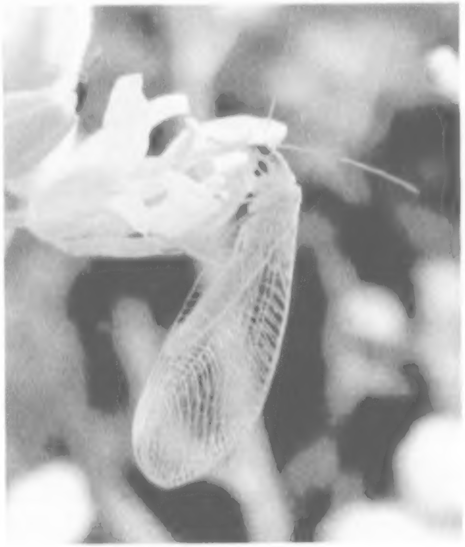
Inspect or beat prey-infested plants over trays or other surfaces for larvae; use a sweep net or light trap for adults.

Conservation

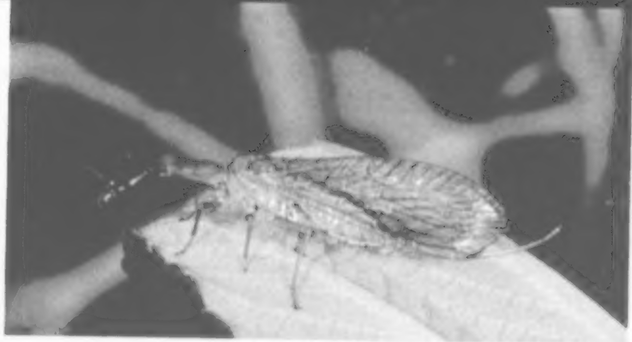
Avoid applying pesticides toxic to adults and larvae when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract adult lacewings to lay eggs. Lacewings will later spread into nearby crops as prey populations develop.

Comments

Adults are active at night when they take short fluttery flights among plants in search of prey and egg-laying sites. Lacewing larvae are active earlier in the season than most predators and can attack early season pests. They insert their piercing mouthparts into prey and inject a toxic saliva that includes digestive enzymes. Commercially available for release.

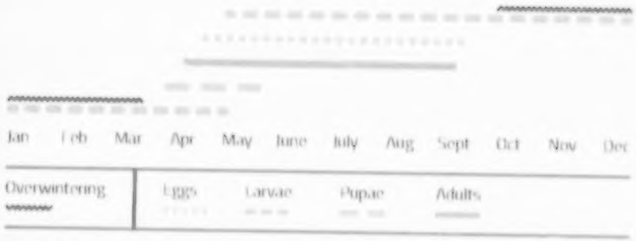


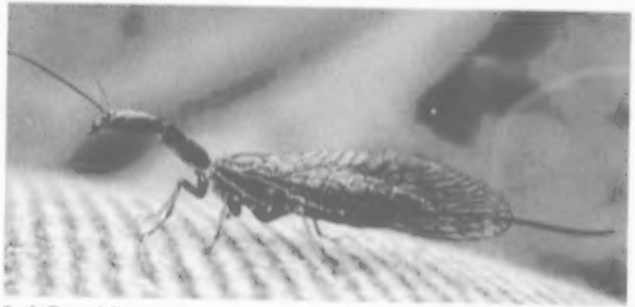
Green lacewing – adult
John Gavloski, Manitoba Agriculture,
Food and Rural Development



Snakefly – adult
J.W. Davies © California Academy of Sciences

Snakeflies





Snakefly – adult
Phil Myers, Museum of Zoology,
University of Michigan-Ann Arbor

Prey

ADULTS: Small, soft-bodied insects.

IMMATURES: Aphids (pp. 59–70), small caterpillars, and various insect eggs.

Identification

ADULTS: 12–25 mm long, shiny dark-gray or dark reddish brown, elongate narrow "neck" (prothorax) behind ovate head equipped with biting mouthparts and long slender antennae; two pair of transparent wings with dark veins held roof-like over the body at rest.

MATURE LARVAE: 12–25 mm long, flattened, mottled reddish or grayish colour with black shiny head and 3 pair of legs that impart great mobility.

Life Cycle

Overwinter mostly as larvae under bark, in bark crevices, or other protected sites. Females use long ovipositor to lay eggs singly or in small batches in bark, crevices, or in plant debris. One generation per year but may take 2–3 years to complete.

Similar species:

None.

Monitoring

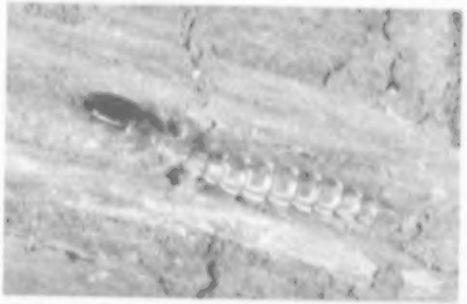
Use a sweep net to detect adults, larvae, and pupae in crops.

Conservation

Avoid applying pesticides toxic to adults and larvae when present. Preserve unsprayed vegetation near fields where prey populations can develop that attract females to lay eggs. Snakeflies will later spread into nearby crops as prey populations develop.

Comments

Adults are poor fliers. The long neck allows the adult to raise its heads like a snake ready to strike. The pupa is free-living, active, and able to use its mandibles.



Snakefly – larva
J.W. Davies © California Academy of Sciences

GLOSSARY OF TERMS

ABDOMEN: The third (posterior) major division of an insect body. It contains digestive and reproductive organs.

ANTENNA: Paired, segmented sensory appendages, usually on the front top of the head.

CATERPILLAR: Another name for the larvae of moths, butterflies, and sawflies.

CEPHALOTHORAX: The first body part of spiders, comprised of the head and thorax fused together.

COMPOUND EYE: A collection of single light-receptor eye units (facets).

CORNICLES: A pair of tubes on the abdomen of aphids that secrete honeydew and alarm pheromones.

CHRYSALIS: The pupa of butterflies and moths.

ECTOPARASITE: A parasite that lives externally on, and at the expense of, a host, but does not kill.

ECTOPARASITOID: A parasite that lives externally on, and at the expense of, a host, which it kills.

ELYTRA: The hardened forewing of beetles that protects the hind wings.

ENDOPARASITE: A parasite that lives internally at the expense of a host, but does not kill.

ENDOPARASITOID: A parasite that lives internally at the expense of a host, which it kills.

FEMUR: The third and usually largest segment of an insect leg.

FOREWINGS: The front pair of wings arising from the thorax.

HALTERE: The small modified hind wing of flies (Diptera) used to keep balance in flight.

HIND WINGS: The second pair of wings arising from the thorax.

HOST: A plant or animal that is a food source for insects and mites.

INSTAR: The growth stage between successive moults.

LARVA: The immature stage after the egg stage, usually restricted to insects that have four developmental stages (complete metamorphosis—egg, larva, pupa, and adult), and do not resemble the adult stage nor always feed on the same hosts.

MAGGOT: A legless, headless larval insect (mostly flies), usually with a tapered body (back to front).

MANDIBLE: The jaws of biting and chewing insects, or modified into slender tubes for piercing and sucking insects.

METAMORPHOSIS: The process of change in body form from the last immature stage to the adult stage.

NYMPH: The immature stage after the egg stage, usually restricted to insects that have three developmental stages (incomplete metamorphosis—egg, nymph, and adult). Usually resemble the adult stage and often feed on the same hosts.

OCELLUS: Simple eye consisting of one facet, usually three in a triangle on the top of the head of adult and nymphal insects (plural ocelli).

OVIPOSITOR: The organ used for egg laying, and usually modified for piercing host tissue in which to deposit an egg(s).

PARASITE: An organism that lives at the expense of a host which it usually does not kill.

PARASITOID: A parasite that kills its host.

POLYEMBRYONY: The production of more than one embryo from a single egg, most common among endoparasitoids.

PREDATOR: An organism that eats more than one prey individual during its lifetime.

PROLEG: The unsegmented leg of a larva, present along the underside of the abdomen.

PUPA: The inactive stage between larva and adult during which metamorphosis occurs.

SPIRACLE: The external opening through which insects breathe, located along the thorax and abdomen.

TARSUS: The terminal section of the leg comprised of up to 6 small segments, often with a claw on the last segment (the insect foot).

TENERAL: The period when the adult insect is newly emerged from the pupal case or nymphal skin and its body has not hardened or darkened.

THORAX: The middle (second) section of the insect body to which are attached the locomotory appendages (wings and/or legs).

TRACHEA: Tubular structures within insect body through which air moves and gases are exchanged (insect respiratory system).

VECTOR: A host of a disease pathogen that transmits it to another organism.

INTERNET INFORMATION RESOURCES

Western Canada Provincial Government Insect/Pest Management Web Sites

- Alberta Agriculture and Rural Development – Crop Insects
  http://www.agric.gov.ab.ca/app21/infopage?cat1=Diseases%2FInsects%2F%20Pests&cat2=Crop%20Insects
- British Columbia Ministry of Agriculture – Field Crop Pests
  http://www.agf.gov.bc.ca/cropprot/entomology.htm
- Manitoba Agriculture, Food and Rural Initiatives – Field Crop Insects
  http://www.gov.mb.ca/agriculture/crops/insects/
- Saskatchewan Agriculture – Crop Protection: Insects
  http://www.agriculture.gov.sk.ca/crop-protection-insects

Reference Publications

- Alberta Agriculture and Rural Development
  - ***Alberta Forage Manual*** – Downlaod free pdf or $30 for hardcopy. Order on-line @
    http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex16
  - ***Alberta Crop Protection Handbook (2013)*** – Download free pdf or $12 for hardcopy. Order on-line @
    http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex32?opendocument
- Manitoba Agriculture, Food and Rural Initiatives
  - ***Guide to Field Crop Protection*** – Downlaod free pdf or $9.82 for hardcopy. Order on-line @
    http://www.gov.mb.ca/agriculture/crops/guides-and-publications/index.html#fcpg
  - ***Field Scouting Guide*** – $25.00. Order on-line @
    http://www.gov.mb.ca/agriculture/crops/guides-and-publications/index.html#fcpg
  - ***Fruit Crop Insect Guide*** – $10.00. Order on-line @
    http://www.gov.mb.ca/agriculture/crops/guides-and-publications/index.html#fcpg
- Saskatchewan Agriculture
  - ***Guide to Crop Protection*** – download pdf of latest edition
    http://www.agriculture.gov.sk.ca/Guide_to_Crop_Protection
- North Dakota State University.
  - ***2013 North Dakota Crop Insect Management Guide*** – E1143. View online @
    http://www.ag.ndsu.edu/pubs/plantsci/rowcrops/e1143.pdf
    or order online @
    http://www.ag.ndsu.edu/publications/landing-pages/crops/2013-north-dakota-field-crop-insect-management-guide-e-1143
- ***Western Committee on Crop Pests Guide to Integrated Control of Insects Pests of Crops*** – recommended control products and application rates for common pests of field crop in Western Canada.
  http://www.westernforum.org/WCCP%20Guidelines.html

Sampling/Monitoring Equipment and Supplies

- Purchasing Sweep Nets For Insect Monitoring
  http://www.gov.mb.ca/agriculture/crops/insects/purchasing-sweep-nets.html
- Monitoring Insects Using a Sweep Net. Manitoba Agriculture, Food and Rural Initiatives
  http://www.gov.mb.ca/agriculture/crops/insects/monitoring-using-sweep-net.html
- Integrated Pest Management – Introduction to Crop Scouting. College of Agriculture, Food and Natural Resources, University of Missouri Columbia, MO (IPM1006)
  http://ipm.missouri.edu/ipm_pubs/ipm1006.pdf
- Prairie Insect Pest Monitoring Network – information on selected field crop pest outbreak forecasts and weekly monitoring updates.
  http://www.westernforum.org/IPMNMain.html

Information on the Biology, Identification, and Management of Field Crop Pests and Their Natural Enemies

- ***Alfalfa Seed Insect Pest Management*** – 2013. J.J. Soroka and D.W. Goerzen. AAFC – Saskatoon Research Centre, Saskatoon, SK
  http://www.saspa.com/PDF/alfalfa%20seed%20insect%20pest%20management%20-%20may%202013.pdf
- ***Biocontrol Arthropods: New Denizens of Canada's Grassland Ecosystems*** – 2011. R. De Clerck-Floate and H. Cárcamo. In ***Arthropods of Canadian Grasslands (Volume 2): Inhabitants of a Changing Landscape***. Edited by K. D. Floate. Biological Survey of Canada. pp. 291-321.
  http://biologicalsurvey.ca/assets/file/76
- ***Biological Control*** – *A Guide to Natural Enemies in North America* – Dr. Anthony Shelton, Cornell University, College of Agricultural and Life Sciences, Dep't of Entomology. This guide provides photographs and descriptions of biological control (or biocontrol) agents of insect, disease, and weed pests in North America. It is also a tutorial on the concept and practice of biological control and integrated pest management (IPM).
  http://www.biocontrol.entomology.cornell.edu/index.php
- ***Cereal Aphids*** – University of Nebraska – Lincoln. Pub. G1284, 2005. Identification and general discussion of the cereal aphid species most commonly found in Nebraska small grains, corn, sorghum, and millet.
  http://www.ianrpubs.unl.edu/pages/publicationD.jsp?publicationId=341
- ***Crop Insects of Kansas*** – 2010. R.J. Whitworth, P.E. Sloderbeck, and H.N. Davis, Dep't of Entomology, Kansas State University. $11.00 (US) plus shipping; order online @
  http://www.ksre.ksu.edu/bookstore/
- ***Cutworms in Field Crops*** – Images and information on common cutworms attacking field crops in Manitoba. Online factsheet.
  http://www.gov.mb.ca/agriculture/crops/insects/cutworms-field-crops.html

- ***Grasshoppers: Their Biology, Identification, and Management*** – Comprehensive sources of information on the biology, ecology, identification, and management of grasshoppers and Mormon crickets in North America.
  http://www.sidney.ars.usda.gov/grasshopper/
- ***Grasshopper Identification and Control Methods to Protect Crops and the Environment*** – Agriculture and Agri-Food Canada, and the Saskatchewan Pulse Growers.
  http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/rsv13511/$FILE/Mar11_2008_grasshopper_book_DJ.pdf
- ***Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control*** – M.L. Flint and S. Dreistadt. University of California Agriculture and Natural Resources. Helps you identify and understand the life histories of predators, parasites, pathogens, competitors, and antagonists that help control specific insect, pathogen, nematode, or weed pests. $35.00 (US). Order online @
  http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_naturalenemies.html
- ***Natural Enemies Gallery*** – University of California Agriculture and Natural Resources. This continuously updated Gallery includes images and indices of natural enemy species commonly found on California farms and landscapes.
  http://www.ipm.ucdavis.edu/PMG/NE/index.html#PREDATOR)
- ***Guide des ravageurs de sol en grandes cultures***.[In French only]
  www.agrireseau.qc.ca/grandescultures/documents/Guide%20des%20ravageurs%20du%20sol_dec%202012.pdf
- ***Natural Enemies of Pests Associated With Prairie Crops*** – 1993.
  J.R. Byers, D.S. Yu. Agriculture et Agroalimentaire Canada. Publication 1895.
  http://publications.gc.ca/collections/collection_2012/agr/A43-1895-1993-eng.pdf

  Available in French: ***Ennemis naturels des ravageurs des cultures dans les provinces des Prairies***
  http://publications.gc.ca/collections/collection_2012/agr/A43-1895-1993-fra.pdf
- Wheat midge control
  www.midgetolerantwheat.ca
- Swede Midge Management Practices
  www.ontariocanolagrowers.ca/

Pest Diagnostic Services (service fees may apply)

- British Columbia Ministry of Agriculture – Pest Diagnostic Laboratory
  http://www.agf.gov.bc.ca/cropprot/lab.htm
- Manitoba Agriculture, Food and Rural Initiatives – Crop Diagnostic Centre
  http://www.gov.mb.ca/agriculture/crops/crop-diagnostic-services/
- Saskatchewan Agriculture – Crop Protection Laboratory Services
  http://www.agriculture.gov.sk.ca/Crop_Protection_Lab

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- Saltmarsh caterpillar
- Seedcorn maggot
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- Alfalfa looper
- Alfalfa weevil
- Black cutworm
- Clover cutworm
- Clover leaf weevil
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- Brown marmorated stink bug
- Cereal leaf beetle
- Chinch bug
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- Green-tan grass bugs
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- Potato aphid
- Redbacked cutworm
- Rice leaf bug
- Saltmarsh caterpillar
- Twospotted spider mite
- Variegated cutworm
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- Wireworms

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- Black cutworm
- Blister beetles
- Grasshoppers
- Saltmarsh caterpillar
- Variegated cutworm
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Flax

- Army cutworm
- Aster leafhopper
- Beet webworm
- Bertha armyworm
- Clover cutworm
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- Flax bollworm
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- Armyworm
- Aster leafhopper
- Black grass bugs
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- Chinch bug
- Corn leaf aphid
- Dingy cutworm
- Fall armyworm
- Glassy cutworm
- Grasshoppers
- Green grass bugs
- Greenbug
- Hessian fly
- Mormon cricket
- Rice leaf bug
- Russian wheat aphid
- Variegated cutworm
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Alfalfa looper
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Black cutworm
Brown marmorated stink bug
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English grain aphid
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Wheat head armyworm
Wheat midge
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Brown marmorated stink bug
Darksided cutworm
Grasshoppers
Green cloverworm
Lygus bugs
Potato leafhopper
Saltmarsh caterpillar
Seedcorn maggot
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Twospotted spider mite
Variegated cutworm

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Beet webworm
Blister beetle
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European corn borer
Pale western cutworm
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Beet webworm
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Brown marmorated stink bug
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Dingy cutworm
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Pale western cutworm
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Beet webworm
Blister beetles
Clover root weevil
Grasshoppers
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Darksided cutworm
Fall armyworm
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Armyworm
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English grain aphid
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  - *Bathyplectes anurus* (Thomson)
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  - *Aphidoletes* spp.
  - *Aphidius* spp.
- *Aphidius avenaphis* (Fitch)
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- *Aphidius colemani* Viereck
  - Green peach aphid, oat-birdcherry aphid
- *Aphidius matricariae* Haliday
  - Bean aphid, potato aphid, pea aphid, green peach aphid, Russian wheat aphid
- *Aphidius ervi* Haliday
  - Potato aphid, pea aphid, green peach aphid
- *Aphidius smithi* Sharma et Subba Rao
  - Aphids
- *Aphidoletes* spp.
  - Aphids
- Armyworm
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  - Bertha armyworm

B

- *Banchus flavescens* Cresson
  - Bertha armyworm
- Black cutworm
  - *Cotesia marginiventris* (Cresson)
- Banded sunflower moth
  - *Chelonus phaloniae* Mason
  - *Glypta prognatha* Dasche
- *Bathyplectes anurus* (Thomson)
  - *Alfalfa weevil*
- *Bathyplectes curculionis* (Thomson)
  - Alfalfa weevil
- Beet webworm
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  - *Banchus flavescens* Cresson,
  - *Trichogramma inyoense* Riley
  - *Athrycia cinerea* (Coquillet)
- *Bracon cephi* (Gahan)
  - Wheat stem sawfly
- *Bracon lissogaster* Muesebeck
  - Wheat stem sawfly

C

- Cabbage seedpod weevil
  - *Microctonus melanopus* (Ruthe)
  - *Trichomalis perfectus* (Walker)
- Celery looper
  - *Cotesia marginiventris* (Cresson)
- Cereal leaf beetle
  - *Tetrastichus julis* (Walker)
- *Chelonus phaloniae* Mason
  - Banded sunflower moth
- Chinch bug
  - *Eumicrosoma beneficum* Gahan
- Corn earworm
  - *Cotesia marginiventris* (Cresson)
- *Cotesia glomerata* (Linnaeus)
  - Imported cabbageworm
- *Cotesia marginiventris* (Cresson)
  - Armyworm
  - Black cutworm
  - Cabbage looper
  - Celery looper
  - Corn earworm
  - Fall armyworm
  - Variegated cutworm
- *Cotesia plutellae* (Kurdjumov)
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D

- *Dacnusa dryas* (Nixon)
  - Alfalfa blotch leafminer
- Damsel bugs
  - Generalist insect predators
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  - Diamondback moth
- Diamondback moth
  - *Diadegma insulare* (Cresson)
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  - *Trichogramma praetiosum* Riley

E

- *Entomophthora grylli* Fresenius
  - Grasshoppers
- *Erixestus winnemana* Crawford
  - Sunflower beetle
- *Eumicrosoma beneficum* (Gahan)
  - Chinch bug
- European corn borer
  - *Trichogramma* spp.
- *Euxestonotus error* (Fitch)
  - Wheat midge

F

- Fall armyworm
  - *Cotesia marginiventris* (Cresson)
- Flax bollworm
  - *Trichomalopsis sarcophagae* (Gahan)

G

- *Glypta prognatha* Dasche
  - Banded sunflower moth
- Grasshoppers
  - *Entomophthora grylli* Fresenius
- Grasshoppers
  - *Nosema locustae* Canning

H

- Hessian fly
  - *Platygaster hiemalis Forbes*

I

- Imported cabbageworm
  - *Cotesia glomerata* (Linnaeus)
  - *Pteromalus puparum* Linnaeus

M

- *Macrocentrus cingulum* Brischke
  - European corn borer
- *Macroglenes penetrans* (Kirby)
  - Wheat midge
- *Metarhizium anisopliae*
  - Wireworms
- *Microctonus melanopus* (Ruthe)
  - Cabbage seedpod weevil (adults)
- *Microplitis plutellae* (Haliday)
  - Diamondback moth
- *Myiopharus macellus* (Reinhard)
  - Sunflower beetle

N

- *Nosema locustae* Canning
  - Grasshoppers

P

- *Peristinus digoneutis* Loan
  - Plant bugs
- *Peristinus pallipes* (Curtis)
  - Plant bugs
- *Phasia robertsonii* (Townesend)
  - Alfalfa plant bug
  - Rice leaf bug
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- Plant bugs
  - *Peristinus digoneutis* Loan
  - *Peristinus pallipes* (Curtis)
  - *Phasia robertsonii* (Townesend)
- *Platygaster hiemalis* Forbes
  - Hessian fly
- *Platygaster tuberosula* (Kieffer)
  - Wheat midge
- *Pteromalus puparum* Linnaeus
  - Imported cabbageworm

S

- Seedcorn maggot
  - *Aleochara bilineata* Gyllenhaal
- Sunflower beetle
  - *Erixestus winnemana* Crawford
  - *Myiopharus macellus* (Reinhard)
  - *Perillus bioculatus* (Fabricius))

T

- *Tetrastichus julis* (Walker)
  - Cereal leaf beetle
- *Trichomalis perfectus* (Walker)
  - Cabbage seedpod weevil larvae
- *Trichomalopsis sarcophagae* (Gahan)
  - Flax bollworm
- *Trichogramma inyoense* Riley
  - Bertha armyworm
- *Trichogramma minutum* Riley
  - Armyworms,
  - Cutworms
- *Trichogramma praetiosum* Riley
  - Beet webworm,
  - Diamondback moth

V

- Variegated cutworm
  - *Cotesia marginiventris* (Cresson)

W

- Wheat midge
  - *Euxestonotus error* (Fitch)
  - *Macroglenes penetrans* (Kirby)
  - *Platygaster tuberosula* (Kieffer)
- Wheat stem sawfly
  - *Bracon cephi* (Gahan)
  - *Bracon lissogaster* Muesebeck
- Wireworms
  - *Metarhizium anisopliae*

CROSS INDEX TO PREDATORS AND THEIR PREY

A

- *Aeolothrips fasciatus* Linnaeus
  - Barley thrips
- *Aleochara bilineata* Gyllenhaal
  - Cabbage, seedcorn, and turnip maggots
- Ambush bugs (*Phymata* spp.)
  - Bumblebees, honey bees, wasps, butterflies, and flies
- Assassin bugs
  - Immature and adults stages of insects

B

- *Balaustium putnami* Smiley
  - Mites
- Barley thrips
  - *Aeolothrips fasciatus* Linnaeus, green lacewings, minute pirate bugs, and predaceous mites
- Bee flies (larvae)
  - Soil inhabiting immature stages of moths, flies, beetles, wasps and bees, and grasshopper eggs
- Big-eyed bugs
  - All stages of soft-bodied insects and on mites
- Brown lacewing
  - All stages of soft-bodied insects and on mites

C

- Crab spiders
  - Any insects visiting flowers

D

- Damsel bug
  - All stages of soft-bodied insects and on mites

E

- *Epicauta* spp.
  - Grasshopper eggs

G

- Green lacewing
  - All stages of soft-bodied insects and on mites
- Ground beetles
  - Immature and adult insects, slugs, snails, and wireworms

H

- Harvestman
  - Spiders, flies, aphids, leafhoppers, snails, and earthworms
- Hover (syrphid) flies
  - Aphids

J

- Jumping spiders
  - Small insects and spiders

L

- Lady beetles
  - Aphids, mites, scale insects, mealybugs, eggs of beetles, and thrips

M

- Minute Pirate bugs
  - Aphids, mites, scales, thrips, small caterpillars, and other small insects

P

- Predatory mites
  - Spider mites, insect eggs and small insects such as thrips, young aphids, and leafhoppers

R

- Red velvet mites
  - Mites and very small insects
- Robber flies
  - Wasps and flies, other flying and soil-inhabiting insects
- Rove beetles
  - Aphids, mites, eggs and larvae of root maggots and other insects, and wireworms

S

- Snakeflies
  - Aphids, small caterpillars, and insect eggs
- Snipe flies
  - Small insects above and below ground
- Stiletto flies
  - Soil-dwelling larvae and pupae of flies, beetles and moths, eggs of grasshoppers, and wireworms
- Syrphid flies (hoverflies)
  - Aphids
- *Systoechus oreas*
  - Grasshopper eggs

T

- Twospotted stink bug
  - Sunflower beetle larvae

W

- Whirligig mites
  - Mites, insect eggs, and very small insects
- Wireworms
  - Ground beetles
  - Rove beetles
  - Stiletto flies
- Wolf spiders
  - Immature and adults insects

RELATIVE TOXICITY RATING OF INSECTICIDES TO COMMON NATURAL ENEMIES OF FIELD CROP PESTS

Natural enemies provide biological control of several important pests of field crops if given the opportunity through adoption of practices that conserve and promote their presence. These conservation practices include:

- Encouraging plant diversity near fields to increase availability of nectar and pollen for adults, alternate prey, and shelter for overwintering.
- Maintaining permanent ground cover as much as possible to provide overwintering sites, and protection from predators and weather extremes.
- Selecting pesticides that are least harmful to natural enemies and applying them only if and when required.

Adults will spread into nearby crops as prey populations develop. Unfortunately many insecticides are harmful to these "free farm workers", either through direct contact with the sprays or with the moist spray deposits. In most cases pesticides are not as harmful to beneficials once the residues are dry. Some pesticides will eliminate beneficials while others will reduce their numbers (suppress), allowing their populations to rebound in the absence of further disruptive sprays. Other pesticides can interfere with reproduction, causing populations to slowly decline or crash depending on the residual activity of the pesticides.

The table on the following page lists the toxicity (L – low; M – moderate; H – high; nd – no data) of pesticides to some species or families of natural enemies. The ratings are compiled from publications which reported assessments based on laboratory studies or field evaluations.

These ratings are a guide only. Individual populations of natural enemies can vary in their susceptibility due to exposure history to the pesticides. Immature stages are more susceptible to poisoning because they are more exposed to treated surfaces from which they cannot escape like the more mobile adults. Foliar sprays are more hazardous to natural enemies than seed treatments. Always use the lowest effective label rate where possible to reduce risks to natural enemies, and because 100% control is not necessary to bring pest populations below economic thresholds.

Active Ingredient	Environmental Impact Quotient[1]	Predatory Mites[2]	*Pnigalio flavipes* (Eulophidae)[2]	Leafroller Parasitoid (Eulophidae)[2]	Ladybugs[2]	Lacewings[2]	Mullein Bug (Miridae)[2]	Minute Pirate Bugs (Anthocoridae)[2]	Trichogrammatidae[2]	Braconidae[2]	Aphid midge (Cecidomyiidae)[2]	*Aphelinus mali* (Aphelinidae)[2]
Acetamiprid	47.50	L-H	nd	H	H	M-H	M-H	H	M-H	M-H	M-H	M-H
Bacillus thuringiensis	15.58	L	L	L	L	L	L	L	L	L	L	nd
Carbaryl	20.70	M-H	L	H	H	L-M	nd	L	H	nd	nd	nd
Chlorantraniliprole	9.50	L	nd	nd	L	L-H	nd	L	nd	nd	nd	L
Chlorpyrifos	23.55	L-M	H	H	H	H	H	H	H	H	H	H
Clothianidin	35.82	M	nd	nd	nd	nd	nd	nd	M-H	nd	nd	nd
Cypermethrin	28.50	H	nd	nd	nd	H	H	H	H	nd	H	nd
Deltamethrin	22.15	H	H	H	H	L	H	H	H	H	H	nd
Diazinon	47.50	L	nd	H	H	nd	H	nd	H	nd	H	nd
Dimethoate	44.75	L-M	nd	H	H	H	H	nd	M	nd	nd	nd
Endosulfan	22.15	L	M	M	M-H	L	M-H	M-H	H	nd	H	nd
Flonicamid	5.00	L-M	nd	M-H	nd	L	nd	nd	nd	nd	L	nd
Imidacloprid	39.33	L-H	L	M-H	M	L-H	M-H	L-M	M-H	M-H	H	nd
Cypermethrin	47.50	H	H	H	H	H	H	H	H	H	H	H
Nosema locustae	–	L	L	L	L	L	L	L	L	L	L	L
Malathion	25.00	nd	L	H	H	H	H	H	H	H	H	nd
Methamidaphos	25.00	nd	H	H	H	H	H	H	H	H	H	nd
Methomyl	25.00	H	H	H	H	H	H	H	H	H	H	nd
Naled	35.82	nd	nd	nd	nd	H	nd	nd	H	L	nd	nd
Novaluron	10.00	L-H	nd	H	L-M	L-H	L-M	L	L	L	nd	nd
Permethrin	25.00	H	H	M	H	H	H	H	H	H	H	nd
Phosmet	31.26	L	L	H	H	L-H	L-M	L-H	H	H	nd	nd
Spinetoram	35.82	M-H	nd	nd	L	L-H	nd	nd	H	nd	nd	nd
Spiromesifen	28.50	L-M	nd	nd	L	nd	L	nd	L	nd	H	nd
Spirotetramat	47.50	L	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Thiamethoxam	36.67	L	nd	nd	L-H	nd	M-H	nd	M-H	nd	nd	nd

[1] These values are based on reported ratings of toxicity to beneficial insects (excl. bees) and the plant surface half-life of the active ingredients. Source: J. Kovach, C. Petzoldt, J. Degni, and J. Tette. 2012. A Method to Measure the Environmental Impact of Pesticides, Table 2: List of Pesticides 2012. IPM Program, Cornell University, New York State Agricultural Experiment Station Geneva, New York 14456. (www.nysipm.cornell.edu/publications/eiq/)

[2] Toxicity ratings: L – low; M – moderate; H – high; nd – no data

ABOUT THE AUTHOR

Hugh Philip was involved in insect diagnostic and agricultural insect pest management research and extension services during a 35-year career with the departments of agriculture in Alberta and B.C. During that time he authored or co-authored two books (*Insect Pests of Alberta, Insect Pests of the Prairies*) and three field guides (*Field Guide to Harmful and Beneficial Insects and Mites of Tree Fruits, Field Guide to Disorders of Fruit Trees, and Field Guide – Invasive Alien Plant Pests and Diseases That Threaten BC Agriculture*). After retirement in 2007 from public service, Hugh embarked on a new career providing consulting services in insect pest management to commodity groups and government agencies from his home in Kelowna, B.C.